General Electric Company
Pittsfield, Massachusetts

Housatonic River – Rest of River

Evaluation of Remedial Alternatives Using Sound Ecological Assumptions

October 2010

Tables

Attachments

Attachment A	Section 3.4 of GE's Interim Media Protection Goals Proposal dated September 6, 2005
Attachment B	Methodology for Determining IMPG Attainment for Insectivorous Birds and Piscivorous Mammals for SED/FP Combinations under the Alternate Ecological Evaluation

1. Introduction

The General Electric Company (GE) has submitted to the United States Environmental Protection Agency (EPA) a Revised Corrective Measures Study (CMS) Report, dated October 2010, presenting evaluations of numerous remedial alternatives to address polychlorinated biphenyls (PCBs) in the Rest of River portion of the Housatonic River. That report was submitted pursuant to a permit issued to GE by EPA under the corrective action provisions of the federal Resource Conservation and Recovery Act (RCRA) on July 18, 2000, and reissued on December 5, 2007, to extend its expiration date (the Permit). As required by the Permit, the evaluations presented in that report took into account EPA's Human Health Risk Assessment (HHRA) (EPA, 2005a, c) and Ecological Risk Assessment (ERA) (EPA, 2004, 2005b) for the Rest of River and used numerous assumptions, procedures, and other inputs that EPA directed GE to use, including Interim Media Protection Goals (IMPGs) based on EPA's HHRA and ERA.

As the Revised CMS Report makes clear, GE disagrees with many of the assumptions, input values, interpretations, and conclusions in EPA's HHRA and ERA, as well as with numerous directives that EPA issued to GE for revising the IMPGs and conducting the CMS. In particular, GE has a fundamental disagreement with EPA regarding whether exposure to PCBs at environmental levels causes adverse effects on human health and the environment. GE has also shown that the exposure assumptions, assumed PCB toxicity values, and other interpretations and conclusions in EPA's HHRA and ERA – and thus underlying the IMPGs – greatly overstate both PCB exposures and asserted PCB risks in the Rest of River area.[1] Since the resulting IMPGs and other inputs that GE was required to use directly affect many of the evaluations presented in the Revised CMS Report, that report should not be regarded as GE's endorsement of the conclusions set forth therein.[2]

The introduction of this document generally discusses the evidence on the human health effects of PCBs and the impact of a scientifically supportable interpretation of that evidence on the assessment of whether the remedial alternatives considered in the Revised CMS Report would provide protection of human health. However, the main focus of this document is to illustrate the impact of applying scientifically sound assumptions and interpretations of the ecological studies and data used in EPA's ERA to evaluate the extent to which the various remedial alternatives would provide protection of the environment. To do so, this document presents the results of using alternate ecological IMPGs and alternate averaging areas for application of those IMPGs, both of which are based on scientifically sound assumptions and data interpretations in contrast to those used in EPA's ERA.

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[1] GE's position on these issues was presented in various prior submittals to EPA, including: GE's comments on EPA's HHRA (AMEC and BBL, 2003, 2005; GE, 2003) and on EPA's ERA (BBL Sciences et al., 2003, 2005; GE, 2004); GE's original IMPG Proposal (GE, 2005), which presented alternate IMPGs, was disapproved by EPA, and was subsequently revised at EPA's direction (GE, 2006b); GE's *Statement of Position on Objections to EPA's Disapproval of Interim Media Protection Goals Proposal* (GE, 2006a); GE's CMS Proposal (ARCADIS BBL and QEA, 2007a); GE's *Statement of Position on Objections to Certain Conditions and Directives in EPA's Conditional Approval of GE's Corrective Measures Study Proposal* (GE, 2007a); and GE's *Statement of Position on Objections to Condition No. 4 in EPA's Conditional Approval Letter for GE's Corrective Measures Study Proposal Supplement* (GE, 2007b).

[2] GE has preserved its position on these issues, and has reserved its right under the Permit to raise any objections on these or other issues in a challenge to EPA's modification of the Permit to select a remedy for the Rest of River.

For purposes of this analysis, GE has focused on a limited set of the combined sediment (SED) and floodplain (FP) remedial alternatives identified and evaluated in the Revised CMS Report – namely: (a) the combination of SED 2 (monitored natural recovery [MNR] in all reaches of the Rest of River) and FP 1 (no action); (b) the combination of SED 3 and FP 3; and (c) the combination of SED 10 and FP 9 (the combination also known as the Ecologically Sensitive Alternative [ESA]).

Overview of Human Heath Data

The scientific evidence demonstrates that the PCB toxicity values that EPA used in the HHRA to represent potential cancer risks and non-cancer effects, which are based on studies of laboratory animals, substantially overstate both the carcinogenic potential and the non-cancer impacts of PCBs in humans. In fact, review of the human studies shows that: (a) there is no credible evidence that PCBs have caused cancer in humans, even in highly exposed PCB workers; and (b) there is no credible evidence that exposure to PCBs at environmental levels has caused adverse non-cancer effects. For example, detailed reviews by Golden et al. (2003) and Golden and Kimbrough (2009) of the human epidemiological studies on cancer have shown that there is no causal relationship between PCB exposure and any form of cancer.[3] Similarly, a comprehensive review of the non-cancer data by Bernier et al. (2001) demonstrates that, with the possible exception of dermal (skin) and ocular (eye) effects in highly exposed PCB workers, there is no reliable evidence of a causal relationship between PCB exposure and adverse non-cancer health effects in humans.

Moreover, studies have demonstrated clearly that human cells are many times less sensitive than the cells of the laboratory test animals used in the studies on which EPA's toxicity values are based (rats and monkeys) to the effects of PCBs, especially the most potent PCB congener (PCB 126), potentially by several orders of magnitude (Silkworth et al., 2005; Westerink et al., 2008; Carlson et al., 2009). Further, the National Research Council's report on EPA's Dioxin Reassessment concluded that the available data on dioxins, including the so-called dioxin-like PCB congeners, support a threshold below which those compounds would not have carcinogenic effects, rather than the EPA assumption that those compounds cause such effects directly proportional to exposure at any and all exposure levels (NRC, 2006, p. 135). These studies confirm that use of the animal-based PCB toxicity values in the HHRA to represent the supposed toxicity of PCBs to humans is not scientifically supportable.

In addition, many of the exposure assumptions that EPA used in the HRRA overstate the exposures of individuals in the Rest of River to PCBs. For example, the HHRA assumed, for the high-use recreational scenario (which EPA applied to the majority of recreational areas in the floodplain), that an individual: (a) recreates in the same floodplain area 3 days/week, 7 months/year (90 days/year) for 65 years; (b) spends 100% of his or her time within the portion of the area containing PCBs over 1 mg/kg; (c) is exposed to PCB concentrations that are among the highest in the area in question (represented by the statistical upper bound of the PCB data) at all times; (d) ingests soil at double the rates shown in

[3] For example, Kimbrough et al. (1999) and Kimbrough et al. (2003) studied a cohort of over 7,000 occupationally exposed workers in two GE capacitor plants and found no statistically significant increase in deaths due to cancer regardless of the degree of PCB exposure of the workers or the length of their employment in the plants.

more recent studies by the same investigators whose studies EPA's ERA relied on; (e) obtains 100% of his or her daily soil ingestion from the contaminated floodplain area; and (f) contacts soil with his or her hands, forearms, lower legs, and head during every exposure event for 5 months.

For these reasons, it is clear that application of the IMPGs based on EPA's HHRA, as presented in the Revised CMS Report, substantially overstates the risks that PCBs might cause cancer and adverse non-cancer effects in humans. In fact, the scientific evidence shows that exposure to PCBs at environmental levels will not cause such human health effects. Given that evidence, all of the combinations of remedial alternatives under evaluation, including SED 2/FP 1, would be protective of human health.

Overview of Assessment of Ecological Data Using Sound Inputs

As discussed above, the main purpose of this document is to illustrate the results of using scientifically sound IMPGs and averaging areas to assess potential impacts of the remedial alternatives on the groups of animals (which EPA calls ecological receptor groups) that were evaluated in EPA's ERA and for which ecological IMPGs were developed. Section 2 describes the alternate IMPGs and averaging areas used for this analysis and the bases for them. Section 3 discusses the extent to which, using these alternate inputs, the three combinations of remedial alternatives mentioned above (SED 2/FP 1, SED 3/FP 3, and SED 10/FP 9) would achieve the IMPGs. It also provides a conclusion regarding the impact of these revised IMPG evaluations on the assessment of whether these combinations would be protective of the environment. Section 4 presents an overall summary. As discussed in that section, this analysis shows that SED 2/FP 1 would be protective of the environment, as well as human health (as described above), and that therefore there is no justifiable basis for selecting a remedy involving removal of sediments and soils, which would unavoidably cause adverse impacts on the vegetation, wildlife, aesthetics, recreational use, and overall ecosystem of the Rest of River.

2. Description of Scientifically Sound Ecological IMPGs and Averaging Areas

This section describes alternate ecological IMPGs, as well as averaging areas for application of those IMPGs, based on scientifically sound assumptions and data interpretations, rather than those used in EPA's ERA.

2.1 Scientifically Sound IMPGs for Ecological Receptor Groups

GE's original IMPG Proposal (GE, 2005) presented alternate IMPGs for the ecological receptor groups to be evaluated. In doing so, GE took into account EPA's ERA by developing such IMPGs for the same receptor groups for which the ERA found significant risks, basing those IMPGs on the same underlying data sets used in the ERA, as well as a number of the same assumptions and procedures used in the ERA, and providing a rationale for any differences. On points on which EPA's data interpretations, analyses, assumptions, and/or toxicity values were not supported by the data and overestimate risks to ecological receptors, the alternate IMPGs were based on scientifically supportable data interpretations or input variables.

The alternate IMPGs that GE developed for ecological receptors and the bases for them, including the rationale for any differences from the data interpretations and inputs used in the ERA, were presented in Section 3.4 of the original IMPG Proposal, a copy of which is attached as Attachment A hereto.[4] Those alternate IMPGs for PCBs have been used, with certain modifications or adjustments, in the assessments presented in this document. The specific alternate IMPGs used here are described below.

Benthic Invertebrates: In assessing risks to benthic invertebrates (insects and other invertebrates that live on the bottom of waterbodies), the ERA relied on site-specific toxicity tests (both chronic and acute) and a site-specific benthic community study conducted by EPA. Based on those data, the ERA identified a variety of effect thresholds based on different test species and/or effects, including sediment concentrations associated with effects on 20% of the organisms tested (EC20s) and sediment concentrations associated with effects on 50% of the organisms tested (EC50s) in the various tests. EPA required GE to set the lower-bound IMPG for benthic invertebrates at 3 mg/kg, based on a combination of the lowest EC20 value from any of the chronic toxicity tests (i.e. the lowest level of PCBs in any test in which an effect was found in 20% of the invertebrates tested) and the five lowest EC20 values from the benthic invertebrate community study. The upper bound of 10 mg/kg was based on the mean of the EC20 values from the acute toxicity tests.

However, use of EC20 values, especially the lowest ones in the various tests, is not appropriate for benthic invertebrates, which have evolved reproductive strategies based on the production of many more offspring than will ultimately survive and thus can well tolerate a 20% or greater reduction in survival or other effects. Section 3.4.1 of the original IMPG Proposal presented several alternate IMPG

[4] In that proposal, the IMPGs were referred to as "Risk-based Media Concentrations" or RMCs.

values for PCBs in sediment based on the different types of benthic invertebrate studies conducted by EPA. These included a range of 7 to 18.5 mg/kg based on EPA's toxicity test data and values of > 42 mg/kg for coarse-gained sediment sites and > 16 mg/kg for fine-grained sites based on EPA's benthic community field study, which was more relevant to the goal of maintaining diverse and abundant communities of benthic invertebrates. For purposes of the evaluations in the present document, GE has used a single, more simplified range. The lower end of that range is 7 mg/kg, which represents the geometric mean (a type of average representing the typical value) of all the EC20 values from the various chronic toxicity tests conducted by EPA. The upper end of the range is 27.8 mg/kg, which corresponds to the geometric mean of the EC50s at coarse-grained sites for the various effects evaluated in EPA's benthic community field study. It is also applicable to fine-grained sites, because adverse effects were seen at lower concentrations at the coarse-grained sites than at the fine-grained sites. Thus, the alternate IMPGs used to assess benthic invertebrates consist of a range of sediment PCB concentrations of 7 to 27.8 mg/kg.

Amphibians: The IMPGs for amphibians were based on a site-specific wood frog study conducted by EPA. That study showed that PCBs had no effects on survival, hatching success, or metamorphosis of frogs, which are directly relevant to the health of the local frog population. The only effects reported in the study were a calculated increase in malformations in wood frog metamorphs (those which have just emerged from the tadpole stage) and a supposed skewing in sex ratio (more females than males), neither of which has a direct relationship to the sustainability of the local wood frog population. EPA required that the lower-bound IMPG, 3.27 mg/kg, be based on the calculated EC20 for metamorph malformations (i.e. the PCB concentration at which malformations were observed in 20% of the metamorphs studied). The upper-bound IMPG, 5.6 mg/kg, was based on the mean of the EC20 for metamorph malformations and the EC50 for sex ratio effects (more females than males).

Use of an EC20 value for metamorph malformations from this study to set an effects threshold for amphibians is not appropriate because, like benthic invertebrates, these frogs have a reproductive strategy in which they produce many more offspring than will ultimately survive and thus can well tolerate a 20% or greater effect, even if the malformations led to mortality. (EPA itself recognized that the EC20 for sex ratio was not biologically relevant.) Thus, use of EC50 values is more scientifically supportable. Section 3.4.2 of the original IMPG Proposal proposed an alternate IMPG range for the protection of amphibians. The lower bound of that range consisted of the EC50 for metamorph malformations (based on spatially weighted mean PCB concentrations in the pools studied in the metamorph portion of EPA's wood frog study), which was 38.6 mg/kg.[5] That value has been used here as an alternate IMPG for the protection of amphibians, and has been applied to PCB concentrations in vernal pool and backwater sediments.

Fish Protection: In developing effects thresholds for PCBs in fish for protection of the fish themselves, the ERA relied on EPA's two-phase site-specific study of reproductive effects of PCBs on fish, which evaluated such effects in adult largemouth bass from the Housatonic and their offspring (Phase I) and in

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[5] This value is conservative given that the study showed no effects of PCBs on wood frog survival, growth, or metamorphosis.

eggs of non-native fish of various species injected with extracts of Housatonic fish (Phase II). The IMPG required by EPA for warmwater fish, 55 mg/kg, was based on a combination of the reported PCB effect threshold from Phase I and an average of the egg-based effect levels from Phase II for warmwater fish (divided by 2 to convert egg concentrations to adult fish concentrations). For coldwater fish – which are found only in reaches downstream of the Primary Study Area (PSA) (which extends from the Confluence to Woods Pond Dam) – EPA required that the IMPG be set at 14 mg/kg, based on dividing the warmwater fish IMPG by a factor of 4, which was arbitrarily selected to reflect the supposed greater sensitivity of coldwater fish such as trout (even though trout eggs were studied in Phase II and showed an effects threshold of 86 mg/kg).

As discussed in Section 3.4.4 of the original IMPG Proposal, Phase I of EPA's study did not show consistent evidence of PCB effects in fish. Therefore, GE proposed alternate IMPG ranges for PCBs based on the effects thresholds (EC50s) from Phase II of the study, but without dividing the egg concentrations by 2 to yield adult tissue concentrations (which has no basis). Further, for coldwater fish, the alternate IMPG was based on data from the trout eggs themselves, instead of applying an arbitrary factor of 4. The proposed IMPG ranges were 86 to 185 mg/kg for warmwater fish in the PSA, 144 to 185 mg/kg for warmwater fish downstream of the PSA, and 86 mg/kg for coldwater fish downstream of the PSA. For simplicity in the evaluations herein, GE has used alternate IMPGs of 86 to 185 mg/kg for all warmwater fish and 86 mg/kg for coldwater fish – both of which have been applied to PCB concentrations in whole-body fish tissue.

Insectivorous Birds: For insectivorous birds, represented by the wood duck, EPA required that the IMPG be based on a calculated effect level (set forth in the ERA) of less than 20% from a 1974 literature study of chickens, a species that has consistently been shown to be many times more sensitive to PCBs than wild bird species, such as wood duck. That IMPG is 4.4 mg/kg of PCBs in insect prey consumed by these birds.

To provide more realistic values for wild insectivorous birds, Section 3.4.8 of the original IMPG Proposal proposed an alternate PCB IMPG range using a similar approach and assumptions to those used to develop the EPA-directed IMPG (as set out in the ERA) except for the toxicity values. That alternate range of IMPGs was developed using three different PCB toxicity values: (1) a low-end value (or lower bound) representing the no observed adverse effect level (NOAEL) in a study of the most sensitive wild avian species, the mallard; (2) a high-end value (or upper bound) reflecting a dose-based effect metric from a site-specific study of a more tolerant species, the tree swallow, conducted at the Housatonic River by EPA; and (3) the midpoint of those two values. The resulting range of alternate IMPGs, which apply to PCB concentrations in the prey of insectivorous birds, was 6.1 mg/kg to 68 mg/kg, with a midpoint of 37 mg/kg.

Because these IMPGs apply to PCB concentrations in the prey of insectivorous birds, they need to be translated into corresponding concentrations of PCBs in sediment and floodplain soil in order to assess whether they would be attained by the remedial alternatives. As discussed in the Revised CMS Report (Section 2.2.2.3), this translation is complicated by the fact that the wood duck's diet consists of both aquatic invertebrates, in which PCB concentrations are derived from sediments, and terrestrial invertebrates, in which PCB concentrations are derived from floodplain soil; and it is not possible to derive a value corresponding to the IMPGs in one medium without knowing the value in the other. In this situation, in evaluating the attainment of these alternate IMPGs for the combinations of sediment and floodplain alternatives, GE has used a procedure similar to that used in the Revised CMS Report for evaluating attainment of the insectivorous bird IMPG for such combinations of alternatives. As described in Section 4.2.3.5 of the Revised CMS Report, since each combined alternative involves a specific sediment component and a specific floodplain component, an assessment of IMPG attainment can be made through the following procedure: (1) determination of the sediment PCB concentration predicted by EPA's model at the end of the projection period in each relevant averaging area; (2) for each such area and sediment concentration, calculation of an associated target floodplain level that would allow attainment of the IMPG (using the method described in Appendix D to the Revised CMS Report); and (3) comparison of the post-remediation floodplain soil concentration in the averaging area to the target floodplain soil concentration calculated for that area.

For purposes of the present analysis, this procedure has been modified so that the above calculations have been made for the entire PSA as a single averaging area (rather than various smaller areas within the PSA), using average input values for the overall PSA. The reason for this approach is that, as discussed in Section 2.2 below, the local wood duck population extends well beyond the individual subreaches and areas of the PSA, and thus the entire PSA represents the most appropriate averaging area for the local wood duck population. This calculation procedure is described in more detail in Attachment B, which also presents the model-predicted sediment levels and the calculated associated target floodplain soil levels for insectivorous birds under each of the combinations of alternatives evaluated herein (SED 2/FP 1, SED 3/FP 3, and SED 10/FP 9). These levels have been used in the present evaluation to assess whether each of these combinations of alternatives would attain the alternate insectivorous bird IMPGs.

Piscivorous Birds: For piscivorous (fish-eating) birds, represented by osprey, EPA required that the IMPG be based the following inputs from its ERA: (1) a PCB toxicity value based on the same literature study of chickens discussed above, even though chickens are substantially more sensitive to PCBs than wild birds; and (2) a modeled food intake rate based on a group of bird species that does not include osprey or any piscivorous birds.[6] The resulting IMPG is 3.2 mg/kg, applicable to PCBs in the fish consumed by these birds.

Section 3.4.6 of the original IMPG Proposal proposed an alternate range of IMPGs for piscivorous birds using a similar approach and assumptions to those used in developing the EPA-directed IMPG (as set out in the ERA), but with different values for the two inputs mentioned above, which do not accurately represent risks to these birds. That alternate range of IMPGs was developed using the same three PCB toxicity values used to develop the alternate IMPG range for insectivorous birds (as described

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[6] It should also be noted that EPA's selection of breeding osprey to represent this category of birds was itself unsupported, since there is no evidence of breeding osprey in the Rest of River area. Most osprey that breed in Massachusetts nest along the coast. The only osprey observed in the Rest of River area during the EPA studies were migratory transients.

above), together with the measured food intake rate in a study of free-living ospreys. The resulting range of alternate IMPGs, which applies to PCB concentrations in the fish consumed by these piscivorous birds, was 6.7 mg/kg to 75 mg/kg, with a midpoint of 41 mg/kg. This range has been used in the evaluations presented in this document.

Piscivorous Mammals: In assessing risks to piscivorous mammals, represented by mink, EPA's ERA relied on its interpretation of a study conducted by EPA, in which farm-raised mink were fed a diet containing fish from the Housatonic River with various PCB concentrations. That study found no effects of PCBs on most of the outcomes studied (e.g., adult survival, breeding and whelping success, litter size, etc.). However, it reported that, at the highest PCB dose level in the study (3.7 mg/kg), there was a significant decrease in kit survival at 6 weeks of age. Based on a statistical analysis of these data, EPA established a 20% effects level for kit survival of 0.984 mg/kg, which is lower than the second highest dose in the study (1.6 mg/kg), at which no effects on survival were found. EPA then required GE to set the lower-bound IMPG for piscivorous mammals at that calculated 20% effects level, 0.984 mg/kg. The upper-bound IMPG was set at 2.43 mg/kg, which is the geometric mean (average representing typical value) of the reported NOAEL (1.6 mg/kg) and the reported lowest observed adverse effect level (LOAEL) (3.7 mg/kg) in the study.

Section 3.4.5 of the original IMPG Proposal explained that EPA's mink feeding study did not provide conclusive evidence of any adverse effects on mink, even at the highest dose in that study (3.7 mg/kg). The reasons include that: (1) EPA's statistical analysis did not adequately take into account the variability in the mink survival data and the lack of a dose-response relationship (i.e., a proportional relationship between PCB exposure and effects); and (2) in any event, kit mortality prior to 6 weeks cannot be attributed to PCB exposure since no necropsies were conducted on the kits that died before 6 weeks, and necropsies on kits that died later confirmed that death was due to infections common in captive mink, not PCBs. GE proposed an alternate IMPG value of greater than 3.7 mg/kg for PCBs in the total diet of mink obtained from the Rest of River area. For the analyses presented herein, that assumed NOAEL (i.e., 3.7 mg/kg in prey items) was used as the dietary IMPG.

As with insectivorous birds, this dietary IMPG needs to be translated into corresponding concentrations in sediment and floodplain soil in order to assess attainment. Again, this translation is complicated by the fact that mink prey consist of both aquatic animals (in which PCB concentrations are derived from sediments) and terrestrial animals (in which PCB concentrations are derived from floodplain soil); and it is thus not possible to derive a target level corresponding to the IMPG in one medium without knowing the value in the other. In this situation, in the Revised CMS Report, GE has used the same procedure described above for insectivorous birds to evaluate attainment of the piscivorous mammal IMPG for the combinations of sediment and floodplain alternatives discussed therein. That procedure involves the following steps: (1) determination of the sediment PCB concentration predicted by the EPA model at the end of the projection period in the relevant averaging area; (2) for each such area and sediment concentration, calculation of an associated target floodplain level that would allow attainment of the IMPG (using the method described in Appendix E to the Revised CMS Report); and (3) comparison of the post-remediation floodplain soil concentration in the averaging area to the target floodplain soil concentration calculated for that area.

For purposes of this present analysis, this procedure has been modified in certain respects. First, as with insectivorous birds, these calculations have been performed for the entire PSA as a single averaging area (rather than dividing that area into two averaging areas, as EPA directed GE to do for the CMS). As discussed in Section 2.2 below, that approach is still highly conservative, because the objective of ecologically based remediation is to protect local populations and communities of biota rather than individual organisms (see EPA, 1999), and the local mink population extends throughout and beyond the PSA. Second, given that mink would forage both within and outside the defined floodplain in the PSA (represented by the 1 mg/kg PCB isopleth), the calculation of target floodplain soil levels has taken into account the proportion of the mink's foraging range that lies outside of that defined floodplain. Mink home ranges extend laterally about 200 meters from shorelines and would encompass tributaries as well as the main stem of the River.[7] Hence, the calculations presented herein included an adjustment to reflect foraging by mink within a corridor that extends 200 meters laterally from all waterbodies within the length of the PSA, including the main stem of the River, backwaters and impoundments, and tributaries to a distance of approximately 0.75 kilometer from the main stem. This foraging area goes beyond the 1 mg/kg isopleth.

This calculation procedure is described in more detail in Attachment B. That attachment also presents, for each of the combination of sediment and floodplain alternatives evaluated here, the model-predicted sediment levels and calculated associated target floodplain soil levels that would allow achievement of the alternate IMPG for piscivorous mammals (i.e., 3.7 mg/kg in prey items). These levels have been used to evaluate attainment of the alternate IMPG for each of these combinations of alternatives.

Omnivorous/Carnivorous Mammals: For omnivorous/carnivorous mammals, represented by the Northern short-tailed shrew, the ERA included an effect level based on EPA's interpretation of a site-specific field study on short-tailed shrews, conducted for GE in the Housatonic River floodplain. The authors of that study (Boonstra and Bowman, 2003) reported no effects of PCBs on any endpoint measured (i.e., density, survival, sex ratio, reproduction rates, growth, and body weight) at floodplain soil PCB concentrations up to a spatially weighted average of 43.5 mg/kg. However, based on its own statistical analysis of the data, EPA concluded in the ERA that there was a statistically significant effect of PCBs on shrew survival and established a statistical threshold level of 21.1 mg/kg of PCBs in soil. EPA then required GE to set the lower-bound IMPG for omnivorous/carnivorous mammals at that level. The upper-bound IMPG, 34.3 mg/kg, was based on the arithmetic average PCB concentration in one of the study grids that, under EPA's analysis, represented a LOAEL.

Section 3.4.3 of the original IMPG Proposal pointed out a number of problems with EPA's statistical analysis and proposed an alternate IMPG for PCBs of greater than 43.5 mg/kg in floodplain soil. This was based on: (a) GE's conclusion that the Boonstra and Bowman (2003) study showed no evidence of significant adverse effects of PCBs on shrew populations in the Housatonic River floodplain; and (b)

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[7] The basis for this home range was discussed in GE's *Statement of Position on Objections to Condition No. 4 in EPA's Conditional Approval Letter for GE's Corrective Measures Study Proposal Supplement* (GE, 2007b).

the consequent conclusion that the highest soil PCB concentration involved in that study (a spatially weighted average PCB concentration of 43.5 mg/kg) represents a NOAEL. As also noted in that section, this conclusion is further supported by EPA's own finding that shrews are the most abundant small mammals in the floodplain (EPA, 2004, Vol.6, p. J-58) and by Boonstra and Bowman's (2003) finding that the short-tailed shrew densities observed in their study are the highest ever reported, which establishes the absence of an adverse effect on the local shrew population from the PCBs present in the ecosystem. For the analyses herein, GE has used this value of 43.5 mg/kg in floodplain soil as the alternate IMPG for the protection of omnivorous/carnivorous mammals.

Threatened and Endangered Species: For threatened and endangered species, represented by the bald eagle, EPA developed a PCB effects threshold in the ERA using an egg-based toxicity value for PCBs from a field study of bald eagles at another site and applying a food intake rate based on a mathematical model for birds in general. That threshold was 30.41 mg/kg for PCBs in the tissue of fish consumed by bald eagles, and EPA required GE to set the IMPG at that level.

Section 3.4.7 of the original IMPG Proposal proposed an alternate range of IMPGs for PCBs, using the same basic approach used in the ERA and to develop the EPA-approved IMPG, but with alternate PCB toxicity values and a more supportable food intake rate. The toxicity values used consisted of: (1) a low-end value that was the same as that used in the ERA; (2) a high-end value from another high-quality study on bald eagles; and (3) the midpoint of those two values. The food intake rate used was the rate presented in EPA's *Wildlife Exposure Factors Handbook* (EPA, 1993), based on the measured rates from field studies of free-flying bald eagles, rather than the modeled rate used in the ERA, which was based on birds in general. The resulting range of alternate IMPGs, which apply to PCB concentrations in the fish consumed by bald eagles, was 37 mg/kg to 93 mg/kg, with a midpoint of 65 mg/kg. This range has been used in the evaluations presented herein.

2.2 Scientifically Sound Averaging Areas for Ecological Receptor Groups

The IMPGs for ecological receptors are applied to designated averaging areas. In considering the appropriate size of these averaging areas, it is important to take into account the objective of ecologically based remediation. As stated in EPA guidance, that objective is to "reduce ecological risks to levels that will result in the recovery and maintenance of healthy local populations and communities of biota" – not to protect "organisms on an individual basis" (EPA, 1999, p. 3). Given this focus on local populations and communities, the averaging areas for the various animal groups to be evaluated should be established on a scale that is commensurate with the area utilized by the local populations or communities of those animals.

Based on this concept, GE proposed in the CMS Proposal (ARCADIS BBL and QEA, 2007a) and CMS Proposal Supplement (ARCADIS BBL and QEA, 2007b) to use, for certain animal groups, averaging areas that extend over the entire PSA. These groups included insectivorous birds (represented by wood ducks), piscivorous mammals (represented by mink), and omnivorous/carnivorous mammals (represented by short-tailed shrews). However, in its conditional approval letters for those documents, EPA directed GE to use smaller averaging areas for these animal groups, which ignore the extent of the local populations of these animals and overemphasize the potential effects of PCBs in small areas. In addition, for amphibians (represented by wood frogs), the CMS Proposal proposed to use EPA's wood frog population model (as described in the ERA), with certain modifications, to evaluate and compare the impacts of floodplain remedial alternatives on the local amphibian population in the PSA and to assess which of the vernal pools in the floodplain would require remediation based on potential population impacts. In its April 13, 2007 conditional approval letter, EPA directed GE not to use EPA's wood frog population model for this purpose in the CMS.

For several animal groups, use of the smaller averaging areas required by EPA is contrary to the objective of protecting local populations of biota. These groups include not only the four animal groups listed above, but also other groups, including piscivorous birds (represented by osprey) and threatened and endangered species (represented by bald eagles). For all of these groups, given the objective to protect local populations, use of the PSA as the averaging area is scientifically supportable and, in some cases, highly conservative (where the local population would extend beyond the PSA). A brief discussion of the averaging area(s) used for each of these groups is presented below. For the other ecological receptor groups, the same averaging areas used in the Revised CMS Report have been used.

Averaging Area for Wood Frogs: EPA's ERA defined the wood frog population in the PSA as those frogs breeding within the vernal pools in the floodplain of the PSA identified as suitable wood frog breeding habitat (EPA, 2004, Vol. 5, App. E. Attachment E.4). To evaluate the impacts of remedial alternatives on this local population, the CMS Proposal proposed to use EPA's wood frog population model with certain modifications; but EPA directed GE not to do so. GE disagrees with that directive, but, for simplicity, has not used that model in the illustrative analyses presented herein. At the same time, the use of every vernal pool and backwater area in the PSA as a separate averaging area (as required for the Revised CMS) is inconsistent with the objective of protecting the local population, which EPA itself defined as all the wood frogs breeding within the PSA vernal pools that have suitable breeding habitat. For the present analysis, GE has calculated a single spatial average PCB concentration across all vernal pools and another across all backwater areas, and applied the alternate amphibian IMPG to those two averaging areas.[8] However, as a sensitivity analysis, the alternate IMPG has also been applied to each vernal pool and each backwater area in the PSA.

Averaging Area for Wood Ducks: Wood ducks do not maintain stable home ranges and their preferred habitat lacks strong natural boundaries. As discussed in Section 4.2.3.3 of the Revised CMS Report, reported sizes of home ranges and foraging ranges for wood ducks are quite variable, with a wide range of reported values. Although a few limited segments of the PSA contain poor or marginal wood duck habitat, given the high mobility of birds, those limited segments do not create boundaries between distinct local populations. Rather, the local wood duck population in the PSA consists of a single, large, contiguous population that is part of an even larger regional population. In this situation, the overall PSA (excluding areas of unsuitable wood duck habitat, as shown on Figure 4-7 of the

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[8] Since different averaging methods were used for vernal pools and for backwaters, a combined average concentration could not readily be calculated for both types of areas together

Revised CMS Report) has been used in this document as the averaging area for evaluating impacts on the local wood duck population.

Averaging Area for Mink: For mink, the PSA represents a highly conservative averaging area for the local population. Since mink are wide-ranging predators, with home ranges for individuals in riverine habitats extending from around 2/3 of a mile to 3-5 miles along shorelines and laterally about 200 meters from the shorelines (see GE 2007b), the PSA (which is about 10 miles long) supports only a portion of the local mink population – i.e., the local mink population in Berkshire County extends well beyond the PSA. EPA's own ERA states that the PSA could contain foraging ranges for "one to several mink" or "more if tributary habitat is included" (EPA, 2004, p. I-7) and that "some individuals may forage part of the time outside the PSA" (*id*. p. I-111). These statements recognize that the mink using the PSA, as well as tributaries and other areas adjacent to the PSA, are simply individuals which make up part of the larger local population.[9] In light of the objective to protect local populations and communities of biota, the pertinent averaging area should be based on the habitat used by the local mink population. Since that habitat extends beyond the PSA, use of the PSA as the averaging area for application of the IMPG levels for mink is highly conservative. For the purposes of the present analysis, the entire PSA (excluding areas of unsuitable mink habitat, as shown on Figure 4-8 of the Revised CMS Report), was used as the averaging area to assess attainment of the piscivorous mammal IMPG. However, as discussed in Section 2.1 and Attachment B, the calculation of the target floodplain soil levels for mink took into account the portion of the mink foraging range between the Confluence and Woods Pond Dam that falls outside the defined floodplain (i.e., the 1 mg/kg PCB isopleth).

Averaging Area for Shrews: As shown in the Revised CMS Report (Section 4.2.3.2. and Figure 4-6a), based on habitat descriptions provided by EPA's consultants, approximately 80% of the floodplain within the PSA contains suitable habitat for shrews. Shrew habitat is contiguous throughout that area without identified natural boundaries. Shrews populate most of the floodplain, and the shrew population is not divided into distinct populations. Rather, it is one large, contiguous local population that is part of a larger population in the Appalachian Mountains (Brant and Orti, 2003). Given the objective of protecting local populations and communities of biota, the entire area of the PSA shown as shrew habitat on Figure 4-6a of the Revised CMS Report has been used in the present analysis as the averaging area for evaluating impacts on and protection of the local shrew population.

Averaging Areas for Osprey and Bald Eagle: Both osprey and bald eagles forage within waterbodies over large distances. For such wide-ranging species, the local populations clearly extend not only throughout the portion of the Housatonic River in the PSA, but also to other waterbodies in the general area. To be conservative, in the present evaluation, the alternate IMPGs for these receptors have been applied to two overall averaging areas – one consisting of Reaches 5 and 6 and the other consisting of Reaches 7 and 8. The average fish concentrations within these two larger areas were calculated as

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[9] This is supported by the May 8, 2009 comments of the Massachusetts Department of Fish and Game (MDFG) on GE's Response to EPA's Interim Comments on CMS Report (which comments were reiterated in EPA's January 15, 2009 conditional approval letter for GE's August 2009 Work Plan) that the local populations of many state-listed rare species go well beyond the PSA. This conclusion applies to mink.

weighted averages of the EPA model-predicted fish concentrations for each of the individual subreaches comprising these two larger averaging areas. The weighting factors used to calculate these averages consisted of two components – one to account for habitat quantity and the other to account for habitat quality – because bald eagles and osprey will forage preferentially where there is the most and the best habitat. Since these receptors prefer open areas for foraging, the first component in developing these weighting factors was the surface area of the River within each reach. The second component was used to account for the relative quality of the different habitat types, given that ospreys and bald eagles generally prefer large open water bodies rather than confined canopies (as in the riverine habitat) or visually occluded water (as in the backwaters) (see Peterson, 1986; Vana-Miller, 1987). Thus, the large impoundments offer the highest quality foraging habitat, followed by the smaller impoundments and backwaters, and then followed by riverine reaches. To reflect these differences, each habitat type was assigned a relative habitat quality weighting factor as follows:

- Riverine habitat: weighting factor = 1, applied to Reaches 5A, 5B, 5C, 7A, 7D, 7F, and 7H;
- Small impoundment and backwater habitat: weighting factor = 3, applied to Reaches 5D, 7B, 7C, 7E, and 7G;
- Large impoundment habitat: weighting factor = 5, applied to Woods Pond and Rising Pond.

The overall weighting factor for each subreach was assigned based on the surface area of the reach multiplied by the applicable habitat quality weighting factor for the reach, as listed above. The weighing calculations and resulting weighted-average fish concentrations for Reaches 5/6 and Reaches 7/8 used in the comparisons to the IMPGs for piscivorous birds and threatened and endangered species are shown for the relevant combinations of alternatives in Table 1.

3. Evaluation of Selected Combinations of Remedial Alternatives

This section provides an evaluation of the extent to which three selected combinations of sediment and floodplain remedial alternatives (SED 2/FP 1, SED 3/FP 3, and SED 10/FP 9) would achieve the IMPGs (which is one of the Selection Decision Factors under the Permit) using the alternate ecological IMPGs and averaging areas described in Section 2. Apart from those inputs, this evaluation followed the same approach and used the same procedures used and described in the Revised CMS Report, including use of EPA's PCB fate, transport, and bioaccumulation model to evaluate the sediment components of these combinations of alternatives. Although GE does not agree with all the EPA-required inputs to the EPA model, GE has used the base-case results of the EPA model runs, as presented in the Revised CMS Report, in the analyses of the sediment components to simplify the analyses and due to the lengthy run times for EPA's model.[10]

Section 3.1 presents comparisons of the modeled sediment or fish concentrations and estimated floodplain soil PCB concentrations resulting from implementation of the selected combinations of alternatives with the alternate ecological IMPGs, using (where applicable) the alternate averaging areas. Section 3.2 provides a discussion of the implications of these comparisons for the assessment of whether these combinations of alternatives would provide overall protection of the environment (one of the General Standards in the Permit).

3.1 Comparisons to Ecological IMPGs

For the ecological receptor groups for which IMPGs were developed, the modeled sediment or fish concentrations and estimated floodplain soil exposure point concentrations (EPCs) resulting from SED 2/FP 1, SED 3/FP 3, and SED 10/FP 9 have been compared to the alternate IMPGs (or range of IMPGs) using (where applicable) the alternate averaging areas described in Section 2. These comparisons are presented in a series of tables (using a similar tabular format to those used for the combinations of alternatives in the Revised CMS Report) as follows:[11]

- Table 2: Benthic invertebrates;
- Table 3: Amphibians (as represented by wood frog);
- Table 4: Protection of fish (warmwater and coldwater);
- Table 5: Insectivorous birds (as represented by wood duck);
- Table 6: Piscivorous birds (as represented by osprey) and threatened and endangered species (as represented by bald eagle);

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[10] GE continues to preserve its position on the issues relating to the model inputs and on all other issues on which it has previously presented its position to EPA; and it reserves the right under the Permit to raise any objections on these or other issues in a challenge to EPA's selection of a remedy for the Rest of River.

[11] As in the Revised CMS Report, in those tables that present model results for predicted sediment or fish concentrations, the numbers of years required to achieve the IMPGs are presented.

- Table 7: Piscivorous mammals (as represented by mink); and
- Table 8: Omnivorous/carnivorous mammals (as represented by short tailed shrew).

These comparisons show the following:

- For benthic invertebrates (Table 2), the model results indicate that SED 2/FP 1 would achieve average surface sediment PCB concentrations below the upper-bound IMPG in 29 of the 32 averaging areas (with most achieved at the present time) and below the lower-bound IMPG in more than half (17) of those areas. SED 10/FP 9 would achieve the upper-bound IMPG in 30 averaging areas and the lower-bound IMPG in 23 of those areas. SED 3/FP 3 would achieve the upper-bound IMPG in all averaging areas and would achieve the lower-bound IMPG in all but one of those areas.

- For amphibians (Table 3), all three combinations evaluated would achieve the IMPG in the overall averaging area comprising all vernal pools in the PSA and in the overall averaging area comprising all backwaters in the PSA. In addition, SED 2/FP 1 and SED 10/FP 9 would achieve the IMPG in 41 of the 66 individual vernal pools in the PSA and in all individual backwater areas. SED 3/FP 3 would achieve the IMPG in all individual vernal pools and backwater areas in the PSA.

- For protection of fish (Table 4), all three combinations would achieve the IMPGs for both warmwater and coldwater fish in all relevant averaging areas, with such levels already achieved at the present time in all areas except two (Reaches 7A and 7C), where it would be achieved within 3 to 7 years.

- For insectivorous birds (represented by wood duck) (Table 5), based on the average model-predicted sediment concentrations in the PSA at the end of the projection period and the associated target floodplain soil target levels that would allow attainment of the insectivorous bird IMPGs (see Attachment B), all three combinations would achieve the upper bound, midpoint, and lower bound of the IMPG range within the PSA.

- For piscivorous birds (represented by osprey) (Table 6), based on the model predictions of whole-body fish PCB concentrations for the relevant size ranges consumed by such birds, all three combinations would achieve the upper-bound and midpoint IMPGs in both averaging areas (with those levels attained at the present time or within the first few years of the simulation). For the lower-bound IMPG, SED 2/FP 1 would not achieve that IMPG in either of the two areas, SED 10/FP 9 would achieve that IMPG in one of the two averaging areas (Reaches 7/8 – in 37 years), and SED 3/FP 3 would achieve that IMPG in both areas (in 51 years for Reaches 5/6 and 11 years for Reaches 7/8).

- For piscivorous mammals (represented by mink) (Table 7), based on the average model-predicted sediment concentration in the PSA at the end of the projection period and the associated floodplain soil target level that would allow attainment of the IMPG (see Attachment B), SED 2/FP 1 would not achieve the IMPG, and both SED 10/FP 9 and SED 3/FP 3 would achieve the IMPG.

- For omnivorous/carnivorous mammals (represented by the short-tailed shrew) (Table 8), all three combinations of alternatives would achieve the IMPG in the PSA.

- For threatened and endangered species (represented by the bald eagle) (Table 6), based on the average model-predicted whole-body fish PCB concentrations for the relevant size ranges consumed by the bald eagle, all three combinations would achieve the upper bound, midpoint, and lower bound of the IMPG range within both averaging areas, with all those IMPGs achieved at the present time (except for the lower-bound IMPG in Reaches 5/6, which would be achieved very shortly after remediation).

3.2 Evaluation of Overall Protection of the Environment

As shown in the Revised CMS Report, achievement of IMPGs is one of several balancing factors under the Permit; it is not determinative of whether an alternative would provide overall protection of the environment. To begin with, as noted above, the overall goal for ecologically based remediation is to "reduce ecological risks to levels that will result in the recovery and maintenance of healthy local populations and communities of biota" (EPA, 1999, p. 3). Thus, in evaluating a particular alternative, it is important to consider the extent to which it would achieve that goal. Moreover, as EPA guidance makes clear, the standard of "overall protection" of the environment includes a balancing of the short-term and long-term adverse ecological impacts of the alternatives with the residual risks (EPA, 1990, 1997, 1999, 2005d). Thus, it is critical that any IMPG exceedances be weighed against the adverse impacts of further efforts to achieve the ecological IMPGs.

In this case, as shown in Section 3.1, using IMPGs and averaging areas that are scientifically sound, the combination of SED 2/FP 1 would achieve levels below or within the range of those IMPGs for all ecological receptors in all averaging areas, with the exception of benthic invertebrates in 3 of the 32 averaging areas and piscivorous mammals in the PSA. However, the exceedances of the IMPGs for benthic invertebrates in 3 averaging areas would not be expected to have an adverse impact on the local benthic invertebrate community, since the local community extends well beyond those few individual areas and the attainment of levels within or below the IMPG range in all other areas is more than sufficient to ensure the maintenance of a healthy local benthic invertebrate community. Moreover, the exceedance of the IMPG for piscivorous mammals in the PSA would not affect the local population of those mammals, as represented by mink, for two reasons: (1) As discussed in Section 2.1, the alternate IMPG itself is conservatively based on a dietary concentration (3.7 mg/kg) that GE has shown was a no-effect level in the mink feeding study, and hence even individual mink would not be expected to experience adverse effects at that level; and (2) in any event, as discussed in Section 2.2, the local population of mink extends beyond the PSA to other, nearby areas outside the Site and thus would likely not be adversely affected by an exceedance of the IMPG level in prey items within the PSA. In addition, the absence of any significant impact of SED 2/FP 1 on the overall wildlife community in the Rest of River area is illustrated by EPA's and GE's field surveys and other field information on the PSA, which have showed that the wildlife community in the PSA consists of numerous, diverse, and thriving species (including many rare species) despite the presence of PCBs in that area for over 70 years.

Furthermore, as noted above, it is critical that any uncertain risks that may be evidenced by IMPG exceedances be weighed against the certain adverse impacts associated with implementing further remedial efforts aimed at achieving the ecological IMPGs. In this case, implementation of SED 2/FP 1 would avoid such adverse impacts, whereas all of the alternatives involving removal would cause substantial short-term and long-term ecological harm, as shown in the Revised CMS Report. In these circumstances, SED 2/FP 1 would meet the standard of providing overall protection of the environment.

As shown in Section 3.1, SED 3/FP 3 would achieve levels within the range of the alternate ecological IMPGs for all receptor groups and all areas, and, where the IMPGs consist of ranges, would achieve the lower bounds of those ranges in all or most areas. On the other hand, as discussed in detail in the Revised CMS Report (Sections 8.2.4.3 and 8.2.7), implementation of that combination of alternatives would result in substantial short-term and long-term adverse impacts of the environment as a result of the removal and capping of sediments throughout Reach 5A, the bank stabilization in Reaches 5A and 5B, the thin-layer capping in portions of Reach 5C and Woods Pond, and the removal or disturbance of approximately 93 acres of the floodplain in the PSA, including mature floodplain forest, vernal pools, and other wetlands. These activities, which would impact a total of approximately 230 acres of ecological habitats in the PSA, would have long-lasting, and in some instances permanent, negative consequences for the plants and animals that use those habitats. As stated by EPA (2005d, p. 6-6), "it is important to determine whether the loss of a contaminated habitat is a greater impact than the benefit of providing a new, modified but less contaminated habitat." That is the situation for SED 3/FP 3. As a result, SED 3/FP 3 would not meet the standard of providing overall protection of the environment.

As also shown in Section 3.1, SED 10/FP 9, would achieve levels below or within the range of the alternate IMPGs for all ecological receptors in all averaging areas, with the exception of benthic invertebrates in 2 of the 32 averaging areas. Again, those limited exceedances would not have an adverse effect on the local benthic invertebrate community for the same reasons discussed above for SED 2/FP 1. Moreover, as explained in the Revised CMS Report (Sections 8.2.4.3 and 8.2.7), this combination of alternatives has been designed to minimize the extent and severity of adverse habitat impacts. In particular, compared to SED 3/FP 3 and the other combinations of alternatives that include extensive sediment and soil removal, SED 10/FP 9 would impact substantially less of the aquatic riverine habitat, the riverbanks, the forested floodplain, and the wetlands in the PSA, and would not directly affect any vernal pools. This combination would affect a total of approximately 90 acres of ecological habitats in the PSA. As a result, the impacts of this combination on the habitats of the PSA would be much more limited in areal extent and less severe than those of SED 3/FP 3 (as well as the larger remediation alternatives) and would not be expected to cause widespread harm to the overall environment in the PSA. For these reasons, SED 10/FP 9 would provide overall protection of the environment.

4. Summary

As discussed in Section 1, due to EPA's use in its HHRA of the animal-based toxicity values for PCBs, together with its use of a number of unrealistic exposure assumptions, the HHRA and the application of the human health IMPGs based thereon (as presented in the Revised CMS Report) substantially overstate the risks that PCBs might cause cancer and adverse non-cancer effects in humans. In fact, the scientific evidence shows that exposure to PCBs at environmental levels does not cause such adverse human health effects. This evidence shows that the combination of SED 2/FP 1 (as well as the other combinations of remedial alternatives under evaluation) would be protective of human health.

The evaluations presented in this document illustrate the impact of using sound assumptions and interpretations of the ecological studies and data used in EPA's ERA on attainment of the ecological IMPGs by remedial alternatives and on the extent to which those alternatives would provide protection of the environment. Specifically, these evaluations have examined the impact of using scientifically supportable ecological IMPGs and averaging areas instead of those that EPA required be used in the Revised CMS Report. As discussed above, the evaluations using those scientifically supportable inputs demonstrate that both SED 2/FP 1 and SED 10/FP 9 would provide overall protection of the environment (although SED 10/FP 9 would cause some negative habitat impacts). Moreover, these evaluations confirm that SED 3/FP 3 (as well as remedial alternatives requiring more extensive sediment and floodplain soil remediation) would not provide overall protection of the environment since they are not necessary to protect ecological receptors from the purported effects of PCBs and would cause severe long-term and, in some cases, permanent adverse ecological impacts on the habitats in the PSA and the plants and animals that use them.

In short, since SED 2/FP 1 would protect both human health and the environment, there is no need or justification for requiring additional remedial actions in the Rest of River area, with the attendant unavoidable ecological damage that would result from remedial construction activities in the River and floodplain.

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Table 1. Calculation of weighted average fish concentrations for piscivorous birds and threatened and endangered species.

Subreach or Averaging Area	Model Grid Area (Acres)	Habitat Quality Factor	Projected Fish Concentrations (mg/kg) [1]					
			Piscivorous birds (represented by osprey)			Threatened and endangered species (represented by bald eagle)		
			SED 2 / FP 1	SED 3 / FP 3	SED 10 / FP 9	SED 2 / FP 1	SED 3 / FP 3	SED 10 / FP 9
Reach 5A	55	1	21	0.55	11	25	0.45	13
Reach 5B	32	1	22	11	17	23	13	19
Reach 5C	69	1	23	7.0	20	24	7.7	21
Reach 5D	57	3	21	15	24	19	15	21
Reach 6	58	5	22	1.9	9.1	18	1.6	6.8
Reach 5-6 Weighted Average[2]			**22**	**6.5**	**15**	**20**	**6.3**	**14**
Reach 7A	14	1	11	2.4	7.2	9.2	2.3	6.2
Reach 7B	11	3	16	8.4	13	16	9.5	13
Reach 7C	8	3	12	4.4	8.6	11	4.7	8.2
Reach 7D	59	1	11	3.4	7.7	10	3.6	7.4
Reach 7E	7	3	7.4	2.2	5.1	6.5	2.2	4.6
Reach 7F	68	1	6.1	1.9	4.2	5.5	1.9	3.9
Reach 7G	13	3	7.3	3.5	5.7	7.0	3.8	5.7
Reach 7H	32	1	5.0	1.5	3.5	4.4	1.5	3.2
Reach 8	44	5	7.8	4.4	6.3	7.7	4.9	6.4
Reach 7-8 Weighted Average[2]			**8.5**	**3.8**	**6.4**	**8.1**	**4.1**	**6.3**

Notes

[1] Model endpoint concentrations after 52-year projection (autumn average) for relevant species and size classes.

[2] Weighted average calculated based on sum-product of area times habitat quality factor times subreach fish concentration, divided by sum-product of area times habitat quality factor.

Table 2. Alternate Evaluation: IMPG attainment for benthic invertebrates for selected SED/FP combinations.

Reach	Exposure Area[1]	Average 0-6" Sediment PCB Concentration (mg/kg)[2]			IMPG Attainment				
		SED 2 / FP 1	SED 3 / FP 3	SED 10 / FP 9	Lower End of IMPG Range (mg/kg)	Upper End of IMPG Range (mg/kg)	SED 2 / FP 1	SED 3 / FP 3	SED 10 / FP 9
5A	R5A_01	1.9	0.33	3.3	7	27.8	*6 / 0*	*1 / 0*	*6 / 0*
	R5A_02	3.7	0.18	0.92	7	27.8	*32 / 0*	*1 / 0*	*1 / 0*
	R5A_03	6.4	0.12	4.8	7	27.8	*48 / 0*	*2 / 0*	*42 / 0*
	R5A_04	29	0.071	27	7	27.8		*2 / 2*	
	R5A_05	13	0.032	1.1	7	27.8	*10*	*2 / 2*	*1 / 1*
	R5A_06	7.7	0.043	2.3	7	27.8	*0*	*3 / 0*	*2 / 0*
	R5A_07	15	0.062	0.77	7	27.8	*0*	*3 / 0*	*2 / 0*
	R5A_08	17	0.028	14	7	27.8	*0*	*4 / 0*	*0*
	R5A_09	9.9	0.022	10	7	27.8	*0*	*4 / 0*	*0*
	R5A_10	16	0.020	17	7	27.8	*0*	*5 / 0*	*0*
	R5A_11	18	0.023	0.95	7	27.8	*0*	*7 / 0*	*3 / 0*
5B	R5B_01	9.6	9.1	9.8	7	27.8	*0*	*0*	*0*
	R5B_02	8.5	5.3	6.9	7	27.8	*0*	*17 / 0*	*22 / 0*
	R5B_03	4.7	3.2	4.4	7	27.8	*5 / 0*	*4 / 0*	*4 / 0*
	R5B_04	5.7	4.4	5.3	7	27.8	*17 / 0*	*12 / 0*	*15 / 0*
	R5B_05	5.6	3.9	5.2	7	27.8	*26 / 0*	*10 / 0*	*12 / 0*
5C	R5C_01	7.2	5.8	7.1	7	27.8	*0*	*33 / 0*	*0*
	R5C_02	8.0	6.4	7.8	7	27.8	*0*	*38 / 0*	*0*
	R5C_03	4.9	3.2	4.4	7	27.8	*11 / 0*	*8 / 0*	*9 / 0*
	R5C_04	6.1	4.4	5.7	7	27.8	*35 / 0*	*21 / 0*	*28 / 0*
	R5C_05	37	1.8	37	7	27.8		*8 / 8*	
	R5C_06	29	1.5	27	7	27.8		*9 / 9*	*48*
6	Woods Pond	16	1.5	3.7	7	27.8	*14*	*10 / 9*	*6 / 4*
7A		0.43	0.41	0.42	7	27.8	*0 / 0*	*0 / 0*	*0 / 0*
7B		4.2	3.9	4.1	7	27.8	*0 / 0*	*0 / 0*	*0 / 0*
7C		4.1	4.0	4.1	7	27.8	*0 / 0*	*0 / 0*	*0 / 0*
7D		1.4	0.92	1.2	7	27.8	*0 / 0*	*0 / 0*	*0 / 0*
7E		1.2	1.2	1.2	7	27.8	*0 / 0*	*0 / 0*	*0 / 0*
7F		0.74	0.61	0.69	7	27.8	*0 / 0*	*0 / 0*	*0 / 0*
7G		5.1	4.7	5.1	7	27.8	*0 / 0*	*0 / 0*	*0 / 0*
7H		0.40	0.39	0.40	7	27.8	*0 / 0*	*0 / 0*	*0 / 0*
8	Rising Pond	2.9	2.7	2.8	7	27.8	*0 / 0*	*0 / 0*	*0 / 0*

Notes

[1] Exposure areas in Reach 5 represent EPA spatial bins (1/4 to 1/2-mile segments as defined in EPA's Model Validation Report)

[2] Model endpoint concentrations after 52-year project

Key:

- (white) *= post-remediation EPC is higher than Upper Bound IMPG*
- (dark blue) *= post-remediation EPC is between Lower and Upper Bound IMPGs*
- (light blue) *= post-remediation EPC is below Lower Bound IMPG*

<value>/<value> = Time to achieve the lower bound and upper bound IMPG, respectively (years)

Table 3. Alternate Evaluation: IMPG attainment for amphibians (as represented by wood frog) for selected SED/FP combinations.

Exposure Area ID [1]	Area (acre)	Floodplain Pre-Remediation EPC (mg/kg) [2]	Floodplain Post-Remediation EPC (mg/kg) or Projected Sediment Concentrations (mg/kg) [2]			IMPG Attainment			
			SED 2 / FP 1	SED 3 / FP 3	SED 10 / FP 9	IMPG (mg/kg)	SED 2 / FP 1	SED 3 / FP 3	SED 10 / FP 9
Floodplain Vernal Pools									
Reach 5-6 Vernal Pools Combined	34	21	21	3.1	21	38.6			
5-VP-3	1.9	73	73	5.6	73	38.6			
5-VP-1	0.044	1.7	1.7	1.7	1.7	38.6			
8-VP-5	0.043	23	23	5.6	23	38.6			
8-VP-4	0.24	3.9	3.9	3.9	3.9	38.6			
8-VP-3	0.024	7.7	7.7	0.021	7.7	38.6			
8-VP-2	0.57	69	69	5.6	69	38.6			
18-VP-2	0.61	7.2	7.2	5.6	7.2	38.6			
18-VP-1	0.28	8.1	8.1	5.6	8.1	38.6			
19-VP-7	0.068	0.84	0.84	0.84	0.84	38.6			
19-VP-2	0.0080	34	34	0.021	34	38.6			
19-VP-1	0.18	32	32	5.6	32	38.6			
19-VP-3	0.031	10	10	5.6	10	38.6			
19-VP-4	0.094	6	6	5.6	6	38.6			
19-VP-8	0.057	91	91	0.021	91	38.6			
19-VP-5	0.51	45	45	5.6	45	38.6			
19-VP-6	1.2	24	24	5.6	24	38.6			
23-VP-2	0.18	47	47	5.6	47	38.6			
23-VP-1	0.30	75	75	5.6	75	38.6			
23A-VP-1	0.45	10	10	5.6	10	38.6			
23B-VP-1	0.068	7.2	7.2	5.6	7.2	38.6			
23B-VP-2	0.091	0.34	0.34	0.34	0.34	38.6			
27B-VP-2	0.28	11	11	5.6	11	38.6			
27B-VP-3	0.062	16	16	0.021	16	38.6			
27B-VP-1	0.072	12	12	5.6	12	38.6			
27-VP-2	0.47	21	21	5.6	21	38.6			
27A-VP-1	0.20	31	31	5.6	31	38.6			
27-VP-1	1.3	23	23	5.6	23	38.6			
26-VP-1	0.036	40	40	5.6	40	38.6			
33-VP-1	0.022	9.5	9.5	0.021	9.5	38.6			
33-VP-2	0.12	70	70	5.6	70	38.6			
38-VP-1	0.43	36	36	5.6	36	38.6			
38A-VP-1	0.020	5	5	5	5	38.6			
38-VP-3	0.046	28	28	5.6	28	38.6			
38-VP-2	0.17	46	46	5.6	46	38.6			
40-VP-3	0.46	67	67	5.6	67	38.6			
40-VP-2	0.36	18	18	5.6	18	38.6			
40A-VP-1	0.11	68	68	5.6	68	38.6			
40-VP-1	0.47	57	57	5.6	57	38.6			
42-VP-1	0.22	64	64	5.6	64	38.6			
42-VP-2	0.28	46	46	5.6	46	38.6			
42-VP-3	0.050	41	41	5.6	41	38.6			

Table 3. Alternate Evaluation: IMPG attainment for amphibians (as represented by wood frog) for selected SED/FP combinations.

Exposure Area ID [1]	Area (acre)	Floodplain Pre-Remediation EPC (mg/kg) [2]	Floodplain Post-Remediation EPC (mg/kg) or Projected Sediment Concentrations (mg/kg) [2]			IMPG Attainment			
			SED 2 / FP 1	SED 3 / FP 3	SED 10 / FP 9	IMPG (mg/kg)	SED 2 / FP 1	SED 3 / FP 3	SED 10 / FP 9
42-VP-5	0.58	73	73	5.6	73	38.6			
42-VP-4	1.0	34	34	5.6	34	38.6			
42A-VP-1	1.5	35	35	5.6	35	38.6			
46-VP-2	7.1	140	140	5.6	140	38.6			
46-VP-1	0.52	1.3	1.3	1.3	1.3	38.6			
46-VP-5	0.056	125	125	0.021	125	38.6			
46-VP-3	1.4	153	153	3.2	153	38.6			
46-VP-4	0.011	125	125	0.021	125	38.6			
49A-VP-1	0.019	16	16	0.021	16	38.6			
49-VP-1	1.2	18	18	5.6	18	38.6			
49B-VP-1	0.0044	26	26	0.021	26	38.6			
66A-VP-1	0.032	0.73	0.73	0.73	0.73	38.6			
69-VP-1	0.0074	12	12	0.021	12	38.6			
8-VP-6	0.086	47	47	5.6	47	38.6			
12-VP-1	0.080	14	14	0.021	14	38.6			
39-VP-1	2.0	39	39	5.6	39	38.6			
54-VP-1	0.20	21	21	5.6	21	38.6			
55-VP-1	0.59	7.6	7.6	5.6	7.6	38.6			
55A-VP-1	2.0	40	40	5.6	40	38.6			
58A-VP-1	0.32	25	25	5.6	25	38.6			
67A-VP-1	0.12	51	51	5.6	51	38.6			
61A-VP-1	0.19	18	18	5.3	18	38.6			
61A-VP-2	1.2	19	19	5.5	19	38.6			
56A-VP-1	0.58	73	73	5.6	73	38.6			
23-VP-3	1.3	22	22	5.6	22	38.6			
Sediment - Backwaters									
Reach 5-6 Backwaters Combined	85.4	---	13	11	13	38.6	*0*	*0*	*0*
Sediment - Small Backwaters (< 2 acres)									
BWS_01	1.9	---	5.7	4.2	5.6	38.6	*0*	*0*	*0*
BWS_02	1.8	---	5.9	5.0	5.6	38.6	*0*	*0*	*0*
BWS_03	1.9	---	3.0	1.8	2.4	38.6	*0*	*0*	*0*
BWS_04	0.30	---	23	22	22	38.6	*0*	*0*	*0*
BWS_06	0.56	---	2.2	0.26	1.3	38.6	*0*	*0*	*0*
BWS_07	0.12	---	5.4	5.4	5.4	38.6	*0*	*0*	*0*
BWS_08	0.35	---	37	37	37	38.6	*0*	*0*	*0*
BWS_09	0.28	---	19	19	20	38.6	*0*	*0*	*0*
BWS_10	1.5	---	16	15	16	38.6	*0*	*0*	*0*
BWS_11	0.11	---	2.1	0.14	1.3	38.6	*0*	*0*	*0*
BWS_12	1.7	---	6.1	4.7	6.0	38.6	*0*	*0*	*0*
BWS_13	0.37	---	10	9.2	10	38.6	*0*	*0*	*0*
BWS_14	0.57	---	8.8	8.1	9.0	38.6	*0*	*0*	*0*
BWS_15	0.90	---	8.9	6.7	9.2	38.6	*0*	*0*	*0*
BWS_16	1.0	---	3.2	1.2	2.8	38.6	*0*	*0*	*0*

Table 3. Alternate Evaluation: IMPG attainment for amphibians (as represented by wood frog) for selected SED/FP combinations.

Exposure Area ID [1]	Area (acre)	Floodplain Pre-Remediation EPC (mg/kg) [2]	Floodplain Post-Remediation EPC (mg/kg) or Projected Sediment Concentrations (mg/kg) [2]			IMPG Attainment			
			SED 2 / FP 1	SED 3 / FP 3	SED 10 / FP 9	IMPG (mg/kg)	SED 2 / FP 1	SED 3 / FP 3	SED 10 / FP 9
BWS_17	0.58	---	2.4	0.44	1.6	38.6	*0*	*0*	*0*
BWS_18	0.84	---	2.3	0.29	1.4	38.6	*0*	*0*	*0*
BWS_19	0.99	---	20	20	21	38.6	*0*	*0*	*0*
BWS_20	1.3	---	5.8	4.4	6.4	38.6	*0*	*0*	*0*
Sediment - Large Backwaters (> 2 acres)									
BWL_01	2.1	---	11	11	11	38.6	*0*	*0*	*0*
BWL_02	5.5	---	5.7	4.2	5.2	38.6	*0*	*0*	*0*
BWL_03	2.4	---	3.6	2.2	3.3	38.6	*0*	*0*	*0*
BWL_04	2.1	---	4.4	2.4	3.8	38.6	*0*	*0*	*0*
BWL_05	12	---	14	12	14	38.6	*0*	*0*	*0*
BWL_07	22	---	20	19	20	38.6	*0*	*0*	*0*
BWL_08	4.1	---	13	11	14	38.6	*0*	*0*	*0*
BWL_09	7.0	---	15	14	15	38.6	*0*	*0*	*0*
BWL_10	6.4	---	13	12	13	38.6	*0*	*0*	*0*
BWL_11	4.6	---	2.3	2.3	2.3	38.6	*0*	*0*	*0*

Key:

(white)	*= post-remediation EPC is higher than IMPG*
(blue)	*= post-remediation EPC is lower than IMPG*

<value> = time to achieve the IMPG as predicted by the model in backwater sediments

Notes:

[1] *See Revised CMS Report Figures 3-18 and 4-5, respectively for locations of backwaters and vernal pools.*

[2] *EPC is calculated for the top 1 ft of soil for vernal pools and as a 0-6" modeled sediment average for backwaters.*

Table 4. Alternate Evaluation: IMPG attainment for protection of warmwater and coldwater fish for selected SED/FP combinations.

Ecological Receptor	Reach	Projected Fish Concentrations (mg/kg) [1]			IMPG Attainment				
		SED 2 / FP 1	SED 3 / FP 3	SED 10 / FP 9	Lower Bound IMPG (mg/kg)	Upper Bound IMPG (mg/kg)	SED 2 / FP 1	SED 3 / FP 3	SED 10 / FP 9
Fish Protection -- Warmwater fish tissue (whole body)	5A	28	0.98	16	86	185	*0 / 0*	*0 / 0*	*0 / 0*
	5B	36	12	25			*0 / 0*	*0 / 0*	*0 / 0*
	5C	29	7.0	22			*0 / 0*	*0 / 0*	*0 / 0*
	5D	36	24	41			*0 / 0*	*0 / 0*	*0 / 0*
	6 (WP)	34	2.8	14			*0 / 0*	*0 / 0*	*0 / 0*
	7A	25	4.8	16			*0 / 0*	*0 / 0*	*0 / 0*
	7B	22	8.2	16			*0 / 0*	*0 / 0*	*0 / 0*
	7C	24	6.7	17			*0 / 0*	*0 / 0*	*0 / 0*
	7D	21	5.2	14			*0 / 0*	*0 / 0*	*0 / 0*
	7E	16	3.9	11			*0 / 0*	*0 / 0*	*0 / 0*
	7F	13	3.1	8.5			*0 / 0*	*0 / 0*	*0 / 0*
	7G	14	4.8	9.9			*0 / 0*	*0 / 0*	*0 / 0*
	7H	11	2.8	7.4			*0 / 0*	*0 / 0*	*0 / 0*
	8 (RP)	14	6.0	10			*0 / 0*	*0 / 0*	*0 / 0*
Fish Protection -- Coldwater fish tissue (whole body) - Trout Below PSA	7A	49	9.6	32	86		*7*	*4*	*5*
	7B	44	16	32			*0*	*0*	*0*
	7C	49	13	33			*5*	*4*	*3*
	7D	42	10	29			*0*	*0*	*0*
	7E	32	7.7	22			*0*	*0*	*0*
	7F	25	6.3	17			*0*	*0*	*0*
	7G	27	9.7	20			*0*	*0*	*0*
	7H	22	5.5	15			*0*	*0*	*0*

Notes

[1] Model endpoint concentrations after 52-year projection (autumn average)

Key

(white)	*= post-remediation EPC is higher than Upper Bound IMPG*
(blue)	*= post-remediation EPC is below IMPG*
<value>/<value>	*= Time to achieve the lower bound and upper bound IMPG, respectively (years), as predicted by the model*
<value>	*= Time to achieve the IMPG (years), as predicted by the model*

Table 5. Alternate Evaluation: IMPG attainment for insectivorous birds (as represented by wood duck) for selected SED/FP combinations.

Averaging Area	Model-Predicted Sediment Endpoint PCB Concentrations (mg/kg)			Calculated Target Floodplain Soil Levels (mg/kg)[1]									Post-Remediation Floodplain EPC (mg/kg)			IMPG Attainment								
				Lower Bound IMPG (6.1 mg/kg in prey)			Mid-Range IMPG (37 mg/kg in prey)			Upper Bound IMPG (68 mg/kg in prey)						Lower Bound IMPG (6.1 mg/kg in prey)			Mid-Range IMPG (37 mg/kg in prey)			Upper Bound IMPG (68 mg/kg in prey)		
	SED 2 / FP 1	SED 3 / FP 3	SED 10 / FP 9	SED 2 / FP 1	SED 3 / FP 3	SED 10 / FP 9	SED 2 / FP 1	SED 3 / FP 3	SED 10 / FP 9	SED 2 / FP 1	SED 3 / FP 3	SED 10 / FP 9	SED 2 / FP 1	SED 3 / FP 3	SED 10 / FP 9	SED 2 / FP 1	SED 3 / FP 3	SED 10 / FP 9	SED 2 / FP 1	SED 3 / FP 3	SED 10 / FP 9	SED 2 / FP 1	SED 3 / FP 3	SED 10 / FP 9
PSA	15	5.1	11	49	67	57	436	454	443	824	841	831	19	15	18									

Key

= *post-remediation floodplain EPC is below calculated target level (and thus prey-based IMPG is met)*

Notes:

[1] *Target floodplain soil levels calculated in accordance with method described in Attachment B.*

Table 6. Alternate Evaluation: IMPG attainment for consumption of fish by piscivorous birds (as represented by osprey) and threatened and endangered species (as represented by bald eagle) for selected SED/FP combinations.

Ecological Receptor	Averaging Area	Projected Fish Concentrations (mg/kg)[1]			Lower Bound IMPG Attainment				Midpoint IMPG Attainment				Upper Bound IMPG Attainment			
		SED 2 / FP 1	SED 3 / FP 3	SED 10 / FP 9	IMPG (mg/kg)	SED 2 / FP 1	SED 3 / FP 3	SED 10 / FP 9	IMPG (mg/kg)	SED 2 / FP 1	SED 3 / FP 3	SED 10 / FP 9	IMPG (mg/kg)	SED 2 / FP 1	SED 3 / FP 3	SED 10 / FP 9
Piscivorous birds (represented by osprey)	Fish tissue (whole body)															
	Reaches 5/6	22	6.5	15	6.7		*51*		41	*5*	*4*	*3*	75	*0*	*0*	*0*
	Reaches 7/8	8.5	3.8	6.4			*11*	*37*		*0*	*0*	*0*		*0*	*0*	*0*
Threatened and endangered species (represented by bald eagle)	Fish tissue (whole body)															
	Reaches 5/6	20	6.3	14	37	*5*	*3*	*3*	65	*0*	*0*	*0*	93	*0*	*0*	*0*
	Reaches 7/8	8.1	4.1	6.3		*0*	*0*	*0*		*0*	*0*	*0*		*0*	*0*	*0*

Notes

[1] Model endpoint concentrations after 52-year projection (autumn average), calculated as weighted average of individual subreach concentrations with weighting factors to account for quanitity and quality of foraging habitat (see Table 1).

Key

(white cell) = *model prediction exceeds the IMPG*

(shaded cell) = *model prediction is lower than the IMPG*

<value> = *Time to achieve the IMPG (years), as predicted by the model*

Table 7. Alternate Evaluation: IMPG attainment for piscivorous mammals (as represented by mink) for selected SED/FP combinations.

Averaging Area	Model-Predicted Sediment Endpoint PCB Concentrations (mg/kg)			Calculated Target Floodplain Soil Levels (mg/kg) [1]			Post-Remediation Floodplain EPC (mg/kg)			IMPG Attainment		
	SED 2 / FP 1	SED 3 / FP 3	SED 10 / FP 9	SED 2 / FP 1	SED 3 / FP 3	SED 10 / FP 9	SED 2 / FP 1	SED 3 / FP 3	SED 10 / FP 9	SED 2 / FP 1	SED 3 / FP 3	SED 10 / FP 9
PSA	15	5.1	11	*n/a*	66	27	19	15	18			

Key

= *post-remediation floodplain EPC is below calculated target level (and thus prey-based IMPG is met)*

Notes:

[1] *Target floodplain soil levels calculated in accordance with method described in Attachment B.*

n/a denotes IMPG values not attainable given the predicted sediment level.

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Table 8. Alternate Evaluation: IMPG attainment for omnivorous/carnivorous mammals (as represented by short tailed shrew) for selected SED/FP combinations.

Averaging Area ID	Area of Averaging Area (acre)	Pre-Remediation EPC (mg/kg) [1]	Floodplain Post-Remediation EPC (mg/kg) [1]			IMPG Attainment			
			SED 2 / FP 1	SED 3 / FP 3	SED 10 / FP 9	IMPG (mg/kg)	SED 2 / FP 1	SED 3 / FP 3	SED 10 / FP 9
PSA	595	20	20	16	19	43.5			

Key:

(white) = *post-remediation EPC is higher than IMPG*

(blue) = *post-remediation EPC is lower than IMPG*

Notes:

[1] *EPC is calculated for the top 1 ft of floodplain soil.*

Attachment A

Section 3.4 from
Interim Media Protection Goals Proposal
For Housatonic River, Rest of River,
Submitted by General Electric Company
on September 6, 2005

3.4 Alternative RMCs Based on Ecological Receptors

This section presents alternative RMCs for each ecological receptor for which the ERA found significant risks – namely, benthic invertebrates, frogs, shrews, fish, mink and otter, ospreys, bald eagles, and wood ducks. These RMCs are based on the same underlying data sets used in the ERA, as well as a number of the same assumptions and procedures used in the ERA to evaluate those data; but they reflect, on several key points, data interpretations or input variables that GE believes are more scientifically supportable than those in the ERA. For each receptor, the discussions in this section reiterate the narrative descriptive goal for the receptor group (which, in each case, is the same as that presented in Section 2.4), and then present the basis for GE's determination of threshold values and the alternative numerical concentration-based RMCs.

3.4.1 Alternative RMCs for Sediments Based on Risks to Benthic Invertebrates

As described in Section 2.4.1, the overall goal for protection of benthic invertebrates is ***to reduce PCB concentrations in sediments as necessary so that they do not prevent the presence of diverse and abundant communities of benthic invertebrates in the Rest of River, consistent with habitat limitations.***

Numerical RMCs for sediments were presented in Section 2.4.1 based on the ERA's interpretation of site-specific studies on benthic invertebrates. This subsection proposes alternative numerical RMCs for PCBs in sediments, which GE believes are more consistent with the underlying data. No RMCs are proposed for TEQs because the ERA did not assess TEQ risks to benthic invertebrates.

Alternative RMCs were developed based on the same site-specific studies that were reported in the ERA, namely, the site-specific toxicity tests and the site-specific benthic community study (Vol. 1, pp. 3-25 - 3-42, 3-47 - 3-57, Vol. 4, pp. D-43 - D-63, D-74 -D-86, D-94 - D-96). For the toxicity tests, the ERA identified a variety of effect thresholds for different test species and endpoints. These thresholds include EC20 and EC50 values, as well as, in some cases, NOELs and LOELs, and are identified in Table 2-4 (in Section 2.4.1 above). GE believes that it is appropriate to use the geometric means of the values listed in Table 2-4 to establish a range of alternative RMCs. Those geometric means are 7 mg/kg for the EC20 values, 13.7 mg/kg for the EC50 values, 13.3 mg/kg for the NOELs, and 18.5 mg/kg for the LOELs.[15]

EPA's Responsiveness Summary for the ERA takes the position that averaging procedures, such as the geometric mean, dilute the results of sensitive endpoints with the results of insensitive endpoints (EPA, 2005b, p. 31). In fact, however, the ERA makes extensive use of geometric means to describe the central tendencies of the various invertebrate data sets and in deriving the MATC (ERA, Vol 4, pp. D-96, D-118). The use of the geometric mean in developing the range of RMCs is thus consistent with the general practice employed in the ERA. In addition, use of these data is consistent with several peer reviewers' recommendation that all relevant data be used to develop toxicity thresholds (EPA, 2004c, pp. 116 & 154 [Thompson], 131 [Forbes], 142 [Sample]). Finally, the geometric mean allows consideration of the central tendency of the full set of relevant data, without putting undue weight on individual data points at the extremes of the distribution range. For these reasons, GE believes that it is appropriate to use the geometric mean of the values listed in Table 2-4 to establish a range of RMC. The proposed alternative range of RMCs derived from the toxicity test data is 7.0 to 18.5 mg/kg in sediments.

For the benthic community study, as discussed in Section 2.4.1, potential effects of PCBs were evaluated separately for sites with fine-grained sediments and high organic carbon content and sites with coarse-grained sediments and low organic carbon. This separation of data into coarse-grained and fine-grained sites provides a basis to control for differences in grain size and organic carbon between the upstream and impounded reaches of the PSA (ERA, Vol. 1, Section 3.2.3 and Figures 3.2-2 and 3.2-3). Such differences can significantly affect benthic community structure independent of PCB concentrations (BBL 2003a, Attachment C).

Based on the separate analyses of the data from the coarse-grained and fine-grained sites, GE has concluded that the benthic community study did not show any important PCB-related effects in either of these sediment types. For the coarse-grained sites, GE's contractors evaluated relationships between benthic community parameters and PCB concentrations, grain size and organic carbon using multiple regression analysis (BBL 2003a, Attachment C). These analyses demonstrated that PCB concentrations accounted for only a very small portion (in the range of

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[15] When the threshold listed in Table 2-4 is ≤ or >, the numeric value was used in this calculation of geometric means. Values listed as "NC" were not used in these calculations.

1.0% to 6.8%) of the variability in the benthic community metrics and thus do not have a major or meaningful influence on the benthic community structure at the coarse-grained sites in the PSA. Results of regression analyses presented in the ERA indicated that PCB concentrations accounted for a somewhat higher, but still relatively small, portion of the overall variability in benthic community parameters at the coarse-grained sites. Based on EPA's analyses, R^2 values for these sites indicated that PCBs accounted for 13% to 17% of the variability in total abundance, 21 to 27% of the variability in taxa richness, and 5% to 21% of the variability in taxonomic diversity indices (ERA, Vol. 4, pp.. D-80, D-81, & Attachment D-8 Table 3).

For the fine-grained sites, the ERA found no significant relationship between PCBs and total abundance (ERA, Vol. 4, p. D-80) and only a borderline statistical relationship between PCBs and taxa richness, with PCBs explaining less than 7% of the variability in this metric (ERA, Vol. 4, p. D-81). For the regressions between PCB concentrations and the three benthic community taxonomic diversity indices at these sites, statistically significant relationships were found only with some methods for treating non-detect values and not others; and in any event, the R^2 values indicated that PCBs accounted for only 7% to 13% of the variability in these indices (ERA, Vol. 4, Attachment D-8, Table 3).

These results demonstrate that, for both the coarse- and fine-grained sites, habitat factors other than PCBs are responsible for the substantial majority of observed variability in benthic community structure. Given that benthic community structure is driven largely by factors other than PCBs, GE believes that it is appropriate to use the maximum concentrations of PCBs in sediments from coarse-grained sites and from fine-grained sites as RMCs for the benthic communities in these two distinct habitats. The maximum station-wide average concentrations of PCBs at the coarse-grained and fine-grained sediment sites are 42 mg/kg and 16 mg/kg, respectively (ERA, Vol. 4, Table D.2-2). The resulting RMC for the coarse-grained sites is thus >42 mg/kg, while that for the fine-grained sites is >16 mg/kg. As noted in Section 2.4.1, GE believes that the results from the benthic community study are more directly relevant than the toxicity test results to the overall goal of maintaining the presence of diverse and abundant communities of benthic invertebrates in the Rest of River.

3.4.2 Alternative RMCs for Vernal Pool and Backwater Sediments Based on Risks to Frogs

As noted in Section 2.4.2, the overall goal for protection of amphibians is ***to reduce PCB concentrations in the sediments of vernal pools and backwaters in the Rest of River as necessary so that they do not prevent those areas from supporting a sustainable reproducing population of amphibians***.

Numerical RMCs were presented in Section 2.4.2 based on the ERA's interpretation of EPA's site-specific study on wood frogs (*Rana sylvatica*) (FEL, 2002). GE previously demonstrated that that interpretation relied on a number of overly conservative assumptions (BBL et al., 2003a,b). GE believes that the alternative numerical RMCs proposed in this subsection are more consistent with the underlying data and provide a more technically appropriate basis for achieving the above goal. No RMCs are proposed for TEQs because the ERA did not assess TEQ risks to amphibians.

The RMCs presented here are based on the GE's interpretation and analysis of data from EPA's site-specific wood frog study (see BBL et al., 2003a,b). The study's three phases yielded data on a wide range of endpoints relevant to the survival, development and maturation of wood frog egg masses, larvae and metamorphs. The proposed RMCs are based on the results of the Phase I and Phase III portions of the study, because they were the only phases that can be evaluated in a way that integrates key responses (i.e., Phase I - malformations, metamorphosis and mortality) or that showed significant dose-response relationships with exposure to vernal pool sediments (e.g., Phase III – malformations and sex ratio).

Phase I Main Study

To understand the combined effects of malformations, mortality, and metamorphosis on the number of normal wood frog metamorphs produced per pond, GE conducted an independent analysis of the net abnormality-free metamorph output for target and reference ponds (i.e., the number of normal metamorphs produced per pond) for the Phase I toxicity study.[16] For all sites, the total metamorph output for each pond was calculated by subtracting the number of

[16] The Phase I Main Study was the only one appropriate for this analysis because both the total number of individuals that completed metamorphosis and the number of metamorphs that had abnormalities were documented. As a result, the total number of abnormality-free metamorphs that were produced from the eggs collected from each site could be determined. The other Phase I studies were not appropriate for this analysis.

metamorphs with abnormalities, regardless of whether the individual abnormality had a dose-response relationship with PCBs, from the total number of metamorphs produced. Regression analyses were used to test the relationship between the net metamorph output and sediment PCB concentrations used in the laboratory studies. There was no evidence of an exposure-response relationship between sediment PCB concentrations and net-metamorph output. Details of this analysis were provided in prior GE comments (BBL et al., 2003a, Attachment G). Based on these analyses, the highest concentration of PCBs in the pond sediments, which was an average measured concentration of 62 mg/kg and estimated to have a spatially weighted mean of 32.3 mg/kg (ERA, Vol. 5, Table E.4-1), represents an unbounded NOAEL. That level can be used as an alternative RMC based on the Phase I study.

Phase III Study

In the Phase III study, metamorphs collected from vernal pools in the Housatonic River floodplain were evaluated based on weight, abnormalities, and sex ratio. Significant relationships were found for both malformations and sex ratio (percent female), but not for weight (ERA, Vol. 5, p. E-91 - E-92)). For malformations, the ERA calculated the following effect thresholds for sediment PCB concentrations: an EC20 of 3.27 mg/kg using the spatially weighted means and 3.61 mg/kg using the average measured concentrations in the ponds; and an EC50 of 38.6 mg/kg using the spatially weighted means and 59.3 mg/kg using the average measured concentrations (ERA, Vol. 5, Table E.4-1). GE believes that the EC50 for malformations is a sufficiently conservative basis for the RMC as there is no evidence that the malformation rates observed affected survival or metamorphosis, and as noted above, review of the Phase I study indicates that the malformation rates did not affect net abnormality-free metamorph output. In addition, the relevance of the malformation rates to the population is questionable. A density-dependent effect, in which the loss of some individuals through malformations would likely be compensated for by increased survival in other individuals that otherwise might not have survived, would mitigate the effect of malformations on the population. Moreover, a statistical analysis conducted by GE (which excluded one site [Site 8-VP-1], due to its very small sample size [n=3]) showed no statistically significant relationship between tissue PCB concentrations (i.e., the delivered dose) and the malformation rate (BBL et al., 2003b), and this finding makes any conclusions regarding the relationship between sediment PCB concentrations and malformation rates unclear. For these reasons, basing an RMC for soil/sediment on the EC20 would be unreasonably conservative. We have thus based the alternative RMC for Phase III malformations on the EC50 of 38.6 mg/kg in sediments (using the spatially weighted means), recognizing that there are uncertainties associated with that effects threshold.

Although the Phase III study also found a significant relationship between increasing PCB concentrations in sediment and the mean percentage of female metamorphs, those data were not used in establishing alternative RMCs. The ERA acknowledged that the biological relevance of sex ratio, at least at the 20% effect level, is unclear (ERA, Vol. 1, p. 4-53; Vol. 5, pp. E-116, E-142). Moreover, as discussed by BBL et al. (2003a,b), an evaluation of the multiple lines of evidence available for sex ratio indicates that there is no clear evidence of PCB-related effects for the following reasons:

- The results of the Phase III study are not consistent with the field data collected by Woodlot in 1999, which indicate that the sex ratios of breeding adult wood frogs were not skewed (44 to 52% female) (ERA, Vol. 5, Att. E.4, Table 5) and were within a range defined as normal by the principal investigators based on a review of the literature (FEL, 2002, p. 41; see also Gilbert et al., 1994; Merrell, 1977; Reeder et al., 1998; and Stebbins and Cohen, 1995).

- GE's statistical analysis showed no statistically significant relationship between tissue PCB concentrations and sex ratio.[17] As tissue PCB concentrations represent the delivered dose to the organism, the finding of no significance on a tissue basis makes any conclusions regarding the significance of the skewed sex ratio unclear.

- The percentage of female metamorphs in the Housatonic River floodplain (not vernal pool specific), calculated as the total number of females/total number of metamorphs collected, was not significantly different from that in the reference area.

- Sex ratios in amphibians can be affected by a number of environmental factors, including temperature, pH, and exposure to chemicals. Because the Phase III study evaluated metamorphs under natural environmental conditions, it is not possible to distinguish effects on sex ratios caused by natural conditions (e.g., temperature, pH) from those related to exposure to PCBs or other contaminants of potential concern. Sex ratios of wood frogs

[17] Again, Site 8-VP-1 was excluded from this analysis due to its very small sample size (n=3).

were not reported for Phase I, a controlled laboratory study where exposure-response relationships could have been rigorously tested.

Given these substantial issues with the sex ratio data, they do not provide an appropriate basis for the development of an RMC

Based on the foregoing data, GE proposes an alternative range of RMCs from 38.6 mg/kg (EC50 for Phase III malformations based on spatially weighted means) to 62 mg/kg (highest average measured concentration in Phase I, considered a NOAEL) for PCBs in vernal pool and backwater sediments. This range of RMCs is supported by the fact that, as the ERA acknowledges, the wood frog study showed no effects of PCBs on survival, growth, and metamorphosis (ERA, Vol. 1, p. 4-46, Table 4.4-5; Vol. 5, E-84 to E-86), and further by the fact that even the malformations found in the study do not appear to have affected the net output of abnormality-free metamorphs (BBL et al., 2003a). Moreover, as noted above, there are substantial issues with the sex ratio data that make them inappropriate as the basis for an RMC.

3.4.3 Alternative RMCs for Floodplain Soil Based on Risks to Northern Short-Tailed Shrew

As noted in Section 2.4.3, the overall goal for protection of northern short-tailed shrews is ***to reduce the PCB concentrations in floodplain soils as necessary so that they do not prevent the presence of an abundant and sustainable population of short-tailed shrews in the Rest of River floodplain, to the extent that such a population can be supported by available habitat.***

Numerical RMCs were presented in Section 2.4.3 for PCBs in floodplain soil based on the ERA's interpretation of Boonstra and Bowman's (2003) site-specific study on potential risks to the short-tailed shrew population. GE previously commented on the substantial uncertainties in the analysis presented in the ERA (BBL et al., 2003a, 2005). GE believes that the alternative numerical RMC proposed here is more consistent with the underlying study. Similar RMCs have not been developed for TEQs, because the ERA predicted no appreciable risks to the short-tailed shrew from TEQs (ERA, Vol. 2, pp. 10-42).

Boonstra and Bowman's (2003) field study assessed whether PCBs were adversely affecting the population demography of short-tailed shrews living in their natural environment. The investigators reported that there were no statistically significant relationships between any of the demographic parameters (i.e., density, survival, sex ratio, reproduction rates, growth and body weight) and the spatially weighted or arithmetic mean concentration of PCBs in floodplain soil in the sampling grids (Boonstra and Bowman, 2003). EPA subsequently reanalyzed the data from this study and found a statistically significant relationship between PCB concentrations in the study grids and shrew survival (ERA, Vol. 6, pp. J-54 - J-55, J-64 - J-66). In response, Dr. Boonstra reanalyzed the data using EPA's exposure assumptions and again found no statistically significant relationship between PCB concentrations and survival (BBL et al. 2003a, Attachment R). Finally, EPA performed a hockey stick regression of the arithmetic mean soil PCB data and shrew survival, and based thereon, it established a MATC of 21.1 mg/kg in soil (ERA, Vol. 6, p. J-82).

Based on review of all the data from and analyses of the Boonstra and Bowman (2003) study, GE believes that the weight of evidence from that study provides no evidence of significant or meaningful adverse effects of PCBs on Housatonic River shrew populations. This conclusion is supported by the following:

- In assessing the effects on survival, GE believes that Dr. Boonstra's reanalysis of the data is more appropriate than EPA's reanalysis. The model used in EPA's reanalysis (Bailer and Oris, 1997) was, according to the cited publication, specifically designed for application to laboratory experiments in which the responses of replicated groups of test organisms exposed to a chemical over a range of concentrations are compared to responses of unexposed control groups. Dr. Boonstra's study, in contrast, was a field study designed to compare shrew populations inhabiting sites with varying habitat quality and contrasting (high vs. low) PCB concentrations. The application of the Bailer and Oris model to Dr. Boonstra's data is contrary to the underlying assumption of this model (i.e., that PCBs are the only factors influencing the populations on each study site).

- In any event, as some of the peer reviewers noted, the fact that the statistical significance of the survival results depends on subtle differences between two statistical methods indicates than any such effect is "borderline" (EPA, 2004c, p. 294 [Forbes]) and "not strong" (EPA, 2004c, p. 298 [Thompson]).

- As noted in Section 2.4.3, the ERA acknowledged that if the same hockey stick regression analysis used to establish the MATC is conducted on the spatially weighted mean soil data (rather than the arithmetic mean data), the results are only borderline significant (EPA, 2005b, p. 62).

- It is undisputed that this study showed no effects of PCBs on any of the other demographic parameters evaluated in the study.

In short, since survival was the only endpoint for which any statistically significant effect was found by EPA, and since the significance of the survival effect depends on which statistical approach and concentration averaging method are used, any PCB-related difference in survival (if any) are marginal and should have no measurable influence on shrew abundance or reproductive success. This is consistent with both with EPA's finding that shrews are the most abundant small mammals on the floodplain (ERA,Vol. 6, p. J-58), and with Boonstra and Bowman's (2003) finding that the short-tailed shrew densities observed in their study are the highest ever reported.

In these circumstances, GE believes that it is reasonable to consider the highest PCB soil concentration involved in the Boonstra and Bowman (2003) study as essentially an unbounded NOAEL. The highest spatially weighted average PCB concentration in floodplain soil in that study was 43.5 mg/kg. Accordingly, GE proposes an alternative RMC of greater than 43.5 mg/kg in floodplain soil for the protection of short-tailed shrews.

3.4.4 Alternative RMCs for Fish Tissue Based on Risks to Fish

As noted in Section 2.4.4, the overall goal for protection of fish is ***to reduce PCB and TEQ concentrations in fish as necessary so that they do not prevent the presence of healthy and self-sustaining populations of fish in the Rest of River, to the extent that such a population can be supported by available habitat***.

Numerical RMCs were presented in Section 2.4.4 for PCBs and TEQs in fish tissue (whole body) based on risks to fish according to the ERA's interpretation of EPA's two-phase site-specific fish reproduction study (Tillitt et al., 2003a, 2003b). GE previously detailed how limitations in the ERA's analysis of these studies led to overly conservative effects thresholds (BBL et al., 2003a). Alternative RMCs are presented in this subsection that GE believes are more consistent with the data. Such alternative RMCs are proposed for both PCBs and TEQs because the ERA established MATCs for both.

The two phases of this fish reproduction study were summarized in Section 2.4.4. A careful review of the data from this study reveals that it did not show consistent relationships between PCB exposure and adverse effects. While the study did find various statistically significant relationships between at least one Housatonic River site and the reference site for a number of adult and offspring endpoints, those differences were not consistent among sites or among developmental phases or between the Phase I and Phase II, and did not show clear exposure-response relationships with PCBs (BBL et al., 2003a, Attachment I).

For the reasons given in GE's prior comments (BBL et al., 2003a, Attachment I), the threshold reported in the ERA for Phase I of the study, as a LOAEL for reduced survival and increased abnormalities in largemouth bass, is not correct because those effects did not occur consistently across Housatonic River sites, did not consistent show exposure-response relationships with PCBs, and were not related to PCB exposure in Phase II. Rather, the Phase I results support an unbounded NOAEL of >149 mg/kg PCB ww, the highest tissue concentration from the study for largemouth bass (Tillitt et al., 2003a).

Phase II provides some limited evidence of effects. The ERA identified a variety of egg-based effect levels (ED50 concentrations in eggs) for the three species evaluated, depending on the location from which the extract was taken, the life stage at which the effect was seen, and the particular trial (ERA, Vol. 5, Table F.3-10). In previous comments (i.e., BBL et al., 2003a, Attachment I), GE identified a number of flaws in these analyses and showed that the ERA's estimates of toxicity thresholds are lower than can be supported by the data. Nonetheless, those thresholds were used here to calculate alternative RMCs, which are highly conservative. As discussed in Section 2.4.4, based on review of the Phase II data presented in the ERA (Vol. 5, Table F.3-10), the species-specific ED50 values for eggs were 185 mg/kg ww PCBs (118 ng/kg ww TEQ) for largemouth bass and means of 144 mg/kg ww PCBs (114 ng/kg ww TEQ) for medaka and 86 mg/kg PCBs (62 ng/kg ww TEQ) for rainbow trout. As shown in GE's prior comments (BBL et al., 2003a, Attachment I), there is no basis for EPA's use of a factor of 0.5 to convert egg concentrations to adult tissue concentrations; no such conversion factor is necessary.

The lack of effects in Phase I of the study and the limited effects in Phase II are consistent with the results of the field surveys conducted by both EPA and GE, which showed no evidence of adverse population-level effects in fish in the PSA (Woodlot, 2002; R2, 2002; Reiser et al., 2004). In particular, GE's field study demonstrated that there is a healthy self-sustaining population of largemouth bass in the PSA (R2, 2002; Reiser et al., 2004).

Based on the above-referenced data and interpretations, GE proposes a range of alternative RMCs for protection of fish. For fish in the PSA, the proposed alternative range would encompass the thresholds for all of the species evaluated – i.e., 86 to 185 mg/kg ww for PCBs and 62 to 118 ng/kg ww for TEQs. For warmwater fish downstream of the PSA, GE proposes the same range of RMCs identified above, excluding the rainbow trout data. This range is 144 to 185 mg/kg ww for PCBs and 62 to118 ng/kg ww for TEQs. For coldwater species downstream of the PSA, GE proposes the rainbow trout thresholds from the Phase II study – i.e., 86 mg/kg ww for PCBs and 62 ng/kg ww for TEQ – as alternative RMCs.

3.4.5 Alternative RMCs for Fish Tissue Based on Consumption by Mink and Otter

As discussed in Section 2.4.5, the overall goal for protection of mink and otter is, ***in areas of appropriate habitat, to reduce PCB concentrations in Housatonic River fish and other mink and otter prey items from the Rest of River, as necessary, so that they do not prevent the presence of sustainable populations of mink and otter that use the Rest of River as part of their home range.***

Numerical concentration-based RMCs were developed for PCBs in the tissue of prey items consumed by mink and otter in Section 2.4.5 based on the ERA's interpretation of EPA's site-specific mink feeding study (Bursian et al., 2003). GE previously commented on the substantial uncertainties in the ERA's the analysis of that study (BBL et al., 2003a, 2005). An alternative RMC is proposed in this subsection based on GE's interpretation of the same site-specific study. That alternative RMC would apply to the average PCB levels in all prey items (combined) consumed by mink and otter. RMCs were not developed for TEQs in these prey items because the ERA found that risks posed to mink and otter from TEQs were unlikely to exceed risks than from PCBs (see ERA, Vol. 2, p. 9-53; Vol. 6, p. I-114). The ERA did not develop a MATC for TEQs in mink or otter diet (see ERA, Vol. 6, pp. I-113, I-114).

The basis for the alternative RMC for PCBs in the diet of mink and otter is the mink feeding study conducted by EPA contractors (Bursian et al., 2003), which is summarized in Section 2.4.5. As discussed above, for 6-week kit survival, that study reported a LOAEL of 3.7 mg/kg in diet and a NOAEL of 1.6 mg/kg in diet. A supplemental probit analysis by EPA estimated an LC20 of 0.984 mg/kg for the same endpoint (ERA, Vol. 6, pp. I-52, I-106). However, for several reasons, GE does not believe that this study provided definitive evidence of adverse effects on kit survival. Those reasons include the following:

- GE conducted an independent statistical analysis of the survival data from this study (BBL et al., 2003a, Attachment N), using essentially the same statistical method used by the authors (Bursian et al., 2003) and reported in the July 2003 draft of the ERA – i.e., an independent repeat measures ANOVA – with one key difference. In GE's analysis, percent survival was calculated by litter within treatments – that is, kit survival for a treatment was calculated based on the average survival in individual litters – instead of being calculated across all kits within a treatment regardless of the litter of origin, as was apparently done by the authors. GE's approach is appropriate because it accounts for the effect of litter on survival. GE's analysis showed no significant effect upon survivability due to dietary treatment (BBL et al., 2003a, Attachment N). The resulting unbounded NOAEL for survival for this study is 3.7 mg/kg PCBs in diet.

- While the probit analysis presented in the ERA was found to be significant, it is apparent, based on Figure I.3-4 of the ERA (Vol. 6), that the probit curve and in particular the confidence intervals do not adequately reflect the spread in results across all treatment groups. As shown by BBL et al. (2005), the survival data are highly variable, and no dose-response is evident, especially given that the second highest treatment group had the highest survivability for the 6-week kit survival endpoint. Moreover, the probit analysis provides a modeled or estimated threshold dose, while the NOAEL determined by ANOVA provides a measured threshold dose.

- In its 2005 Responsiveness Summary, EPA suggested that the NOAEL and LOAEL represent test levels that might not necessarily correspond to biologically relevant thresholds (EPA, 2005b, p. 56). It also suggested that problems with experimental design, such as small sample size and improper spacing of treatment doses, may "mistakenly indicate that a substance is less toxic than it really is" (EPA, 2005b, pp.56). These comments were taken from the literature and reflect potential issues in the use of NOAELs and LOAELs in the interpretation of exposure-response data. However, they are not directly relevant to the specific design employed in the mink feeding. That study focused on reproduction, which is a biologically relevant endpoint; and it had a large sample size and used a tightly bracketed range of five exposures (i.e., 0.34 to 3.7 mg/kg diet) that was based specifically on prior studies evaluating reproductive effects of PCBs on mink.

- In any event, as shown in GE's prior comments (BBL et al., 2003a), kit mortality prior to 6 weeks in this study cannot be attributed to PCB exposure since no necropsy data were reported for those kits, and necropsies on kits that died later showed that their deaths were due to non-PCB-related causes.

For these reasons, GE believes that EPA's mink feeding study did not provide clear evidence of adverse effects on mink, even at the highest dose in the study, which was 3.7 mg/kg PCBs in diet. Based on this conclusion, GE proposes an alternative RMC of greater than 3.7 mg/kg for PCBs in the total diet of mink and otter that is obtained from the Rest of River area.

Moreover, in considering the overall goal of addressing PCB impacts that would prevent the presence of a sustainable population of mink and otter that use the Rest of River as part of their home range, GE believes that the results of its field survey of mink and otter (Bernstein et al., 2003) are relevant. That survey indicated, based on the spatial and temporal distribution of mink and otter tracks and other signs, that even under current conditions, mink and river otter use the PSA as part of their home range in estimated numbers that are within the range of densities that might be expected for such riverine habitat based on the literature (Bernstein et al., 2003; BBL et al., 2003a, Attachments O and P).

3.4.6 Alternative RMCs for Fish Tissue Based on Consumption by Ospreys

As noted in Section 2.4.6, the overall goal for protection of ospreys is, ***in areas of appropriate habitat, to reduce PCB concentrations in Housatonic River fish as necessary so that they do not prevent the presence of a population of ospreys in the Rest of River, taking into account the home range of such osprey***.

In Section 2.4.6, numerical RMCs were presented for PCBs in fish tissue (whole body) based on fish consumption by osprey in the Rest of River, using methods and assumptions consistent with the ERA. However, consistent with prior GE comments (BBL et al., 2003a), we believe that the ERA employed a number of overly conservative assumptions and that more accurate and realistic RMCs can be generated using alternative methods. Such alternative numerical RMCs for PCBs are presented in this subsection. RMCs were not developed for TEQs because the

ERA predicted lower risks to the osprey from TEQs than from PCBs and indeed characterized the TEQ risks as unclear (ERA, Vol. 2, p. 8-42; Vol. 6, pp. H-73, H-74). Separate alternative PCB RMCs have been developed for breeding and transient ospreys in the Rest of River area.

To generate alternative RMCs, the HQ equation was solved for the fish concentration term, as follows:

$$RMC_{fish} = THQ * TRV / (FT * FIR)$$

Where:

RMC_{fish}	=	Concentration of PCBs in fish that will not cause exceedance of TRV (mg/kg)
THQ	=	Target hazard quotient (unitless)
TRV	=	Toxicity reference value (mg/kg bw/d)
FT	=	Foraging time (unitless)
FIR	=	Normalized food intake rate (kg/kg bw/d)

In this equation, the target HQ (THQ) was set at 1.0 to ensure that the dose does not exceed the TRV. RMCs were calculated based on three TRVs. To represent the most sensitive species, we used a TRV of 1.4 mg/kg bw/d, which reflects the NOAEL for the most sensitive wild avian species, the mallard, in a study by Custer and Heinz (1980). This study provides a more appropriate basis for the TRV than the dated Lillie et al. (1974) study on white leghorn chickens, which was used in the ERA, because chickens are domesticated and are substantially more sensitive than wild species to PCBs (Bosveld and Van den Berg, 1994). To represent the most tolerant species, we used a TRV of 15.7 mg/kg bw/d, which is the site-specific and stressor-specific dose-based effect metric derived from Custer's (2002) study on tree swallows breeding on the Housatonic River. This site-specific study offers the advantages of temporal and spatial representativeness, as well as consistency in the PCB mixture and habitat variables. Furthermore, because Custer (2002) demonstrated that Housatonic River tree swallows are more tolerant of PCBs than are the American kestrels studied by Fernie et al. (2001) (i.e., the tree swallow TRV is higher than that of kestrels), it is appropriate to use this tree swallow study to represent the most tolerant avian species in defining the range of avian TRVs. The third TRV, 8.55 mg/kg bw/d, is the midpoint of the other two TRVs.

RMCs were initially calculated based on the assumption that 100% of the osprey's foraging time (FT) is within the Rest of River (ERA, Vol. 2, p. 8-11; Vol. 6, pp. H-23, H-24). Fish were assumed to comprise 100% of the osprey's diet (ERA, Vol. 2, p. 8-13; Vol. 6, p. H-26).

The ERA modeled the food intake rate (FIR) of ospreys from a bird algorithm that is not specific to ospreys, but is instead based on Charadriiformes (a taxonomic order that does not include ospreys or any piscivorous birds of prey). Because this algorithm requires inputs for various factors for which limited data are available, the results are highly uncertain. In particular, because Charadriiformes tend to be substantially smaller than ospreys, their metabolism and normalized food intake rate are substantially higher than those of ospreys. Given these limitations, alternative RMCs for ospreys were calculated based on the measured food intake rate of 0.21 kg/kg bw/d for free-living ospreys (Poole, 1983) listed in EPA's (1993) *Wildlife Exposure Factors Handbook.*

Based on the methods and assumptions described above, the resulting range of alternative RMCs for PCBs in fish is 6.7 mg/kg to 75 mg/kg, with a midpoint of 41 mg/kg. These RMCs are applicable only to ospreys breeding in the Rest of River, since they assume that 100% of the osprey's foraging time is within the Rest of River.

For the same reasons given in Section 2.4.6, numerical RMCs have also been calculated for transient ospreys in the Rest of River. These RMCs were based on the assumption that ospreys are present in the Rest of River only 3 days per year (0.8% of the year) as they are migrating. Applying a value of 0.008 for the FT term in the equation above, and using all other exposure assumptions and TRVs described above, yields RMCs for PCBs in fish in the range of 833 mg/kg to 9,345 mg/kg, with a midpoint of 5,089 mg/kg.

In conclusion, the alternative PCB RMCs for ospreys breeding within the Rest of River (if any) range from 6.7 mg/kg to 75 mg/kg in fish tissue, with a midpoint of 41 mg/kg. The alternative RMCs for transient ospreys range from 833 to 9,345 mg/kg, with a midpoint of 5,089 mg/kg.

3.4.7 Alternative RMCs for Fish Tissue Based on Consumption by Bald Eagles

As noted in Section 2.4.7, the overall goal for protection of bald eagles is, ***in areas of appropriate habitat, to reduce PCB concentrations in Housatonic River fish as necessary***

so that they do not have adverse reproductive effects on bald eagles in the Rest of River, taking into account the home range of such eagles.

In Section 2.4.7 of this proposal, numerical risk-based RMCs were presented for PCBs in fish tissue (whole body) based on fish consumption by bald eagles in the Rest of River, using methods and assumptions consistent with the ERA. However, based on prior GE comments (BBL et al., 2003a), we believe that the ERA employed a number of overly conservative assumptions and that more accurate and realistic RMCs can be generated using alternative methods. Such alternative numerical RMCs for PCBs in fish (whole body) based on consumption by bald eagles are presented in this subsection. Separate alternative PCB RMCs have been developed for resident and transient bald eagles. Those developed for resident bald eagles apply to both breeding and wintering eagles, while those developed for transient bald eagles apply to eagles that temporarily forage at the Rest of River during migration. RMCs were not developed for TEQs because the ERA did not predict greater risks to bald eagles from TEQs than from PCBs (both were considered high – see ERA, Vol. 2, p. 11-46; Vol. 6, p. K-88) and did not develop a MATC or other threshold concentrations for TEQs in fish based on consumption by bald eagles (see ERA, Vol. 6, pp. K-68 - K-69).

Like the MATC presented for bald eagles in the ERA (discussed in Section 2.4.7), the alternative RMC reflects the concentration of PCBs in fish that yields a maternal dose that leads to a bald eagle egg concentration equal to the egg-based TRV. To derive that RMC mathematically, the target HQ of 1.0 was first set equal to the ratio of the estimated PCB concentration in eggs ([egg] in mg/kg) to the egg-based TRV (TRV_{egg} in mg/kg). This is equivalent to setting the estimated egg concentration equal to the egg-based TRV – i.e.:

$$[egg] = TRV_{egg}$$

From Bargar et al.'s (2001) work, the estimated egg concentration may also be expressed as a function of the maternal body burden:

$$[egg] = CR_{e:a} * [adult]$$

Where:

$CR_{e:a}$ = Concentration ratio of eggs to adults (unitless)

[egg] = Estimated concentration of PCBs in eggs (mg/kg)
[adult] = Adult body burden of PCBs (mg/kg)

Since the previous two equations both define the estimated concentration of PCBs in eggs [egg], they may be set equal to one another:

$$TRVegg = CR_{e:a} * [adult]$$

Next, the adult body burden [adult] was calculated consistent with the ERA (Vol. 6, pp. K-27 to K-29):

$$[adult] = \sum_{j=2}^{30} CAE * FT * FIR * RMC_{fish} * P_{fish} * 1day$$

Where:

[adult]	=	Adult body burden of PCBs (mg/kg)
j	=	Days in pre-laying period (days)
CAE	=	Chemical absorption efficiency (unitless)
FT	=	Foraging time (unitless)
FIR	=	Normalized food intake rate (kg/kg bw/d)
RMC_{fish}	=	Concentration of PCBs in fish that will not result in exceedance of TRV_{egg} (mg/kg)
P_{fish}	=	Proportion of fish in diet (unitless)

The preceding two equations were then combined as follows:

$$TRV_{egg} = CR_{e:a} * \sum_{j=2}^{30} CAE * FT * FIR * RMC_{fish} * P_{fish} * 1day$$

Finally, the RMC in fish was calculated by solving the above equation for RMC_{fish}. Microsoft Excel's solver function was used to facilitate solving this equation for RMC_{fish}. The basis for each input value is summarized below.

Consistent with the ERA, (Vol. 6, p. K-29), bald eagles were assumed to arrive at the Rest of River with no PCB load 30 days before initiating egg-laying. Hence, accumulation of PCBs was calculated over days 2 through 30 of the pre-laying period.

Alternative RMCs were calculated based on two egg-based TRVs for bald eagles, as well as the midpoint of those two TRVs. The minimum alternative RMC was calculated using the Stratus (1999) TRV of 20 mg/kg, which was also employed in the ERA. The maximum alternative RMC was calculated using another high-quality field study on bald eagles by Donaldson et al. (1999), which yielded a TRV of 50 mg/kg. The midpoint of those two TRVs, 35 mg/kg, was used to calculate the midpoint alternative RMC for bald eagles.

Consistent with the ERA, (Vol. 6, p. K-28, K-29), the concentration ratio of eggs to adults ($CR_{e:a}$) was set equal to the mean value of 0.22, as reported by Bargar et al. (2001) for white leghorn chickens. It was conservatively assumed that avian species do not metabolize PCBs (ERA, Vol. 6, p. K-27). Consistent with the ERA (Vol. 6, p. K-28), the chemical absorption efficiency (CAE) for fish was assumed to be 0.89. In order to initially focus the analysis on resident bald eagles, foraging time (FT) was assumed to be 1.0. The proportion of fish in the diet (P_{fish}) was assumed to be 0.786, consistent with the ERA (Vol. 2, p. 11-12; Vol. 6, p. K-16, Table K.2-1).

The normalized food intake rate (FIR) was assumed to be 0.12 g/g BW/d, based on the value reported in EPA's (1993) *Wildlife Exposure Factors Handbook* from the Stalmaster and Gessaman (1984) study of free-flying adult bald eagles in Washington and from the Craig et al. (1988) study of free-flying adult bald eagles in Connecticut. This FIR differs from that used in the ERA, which was modeled based on an algorithm for birds in general, rather than bald eagles in particular. The general bird algorithm required inputs for several key factors for which there are limited data, but which are shown in the sensitivity analysis to strongly influence the results (ERA, Vol. 6, Table K.2-7). Although the ERA dismissed the Stalmaster and Gessaman (1984) and Craig et al. (1988) studies on the ground that some eagles apparently did not feed exclusively at the established feeding stations (ERA, Vol. 6, pp. K-14, K-15), the measured rates reported by Stalmaster and Gessaman (1984) and Craig et al. (1988) were employed in this analysis because EPA's (1993) *Wildlife Exposure Factors Handbook* recognizes that measured rates are preferable to modeled rates.

Based on these methods and exposure assumptions, the alternative egg-based RMCs for PCBs in fish that are protective of resident bald eagles range from 37 mg/kg to 93 mg/kg, with a midpoint of 65 mg/kg. These RMCs are applicable only to bald eagles breeding or wintering in the Rest of River, since they assume that 100% of the eagle's foraging time is within the Rest of River.

Alternative RMCs have also been calculated for transient bald eagles, based on the assumption that some bald eagles are present in the Rest of River only 3 days per year (0.8% of the year) as they are migrating. Applying a value of 0.008 for the FT term in the equation above, and using all other exposure assumptions and TRVs described above, yields egg-based RMCs for PCBs in fish ranging from 4,668 mg/kg to 11,670 mg/kg, with a midpoint of 8,169 mg/kg. These values are proposed as alternative RMCs for transient bald eagles.

3.4.8 Alternative RMCs for Aquatic Invertebrates Based on Consumption by Wood Ducks

As noted in Section 2.4.8, the overall goal for protecting wood ducks is, ***in areas of appropriate habitat, to reduce PCB and TEQ concentrations in Housatonic River aquatic invertebrates as necessary so that they do not prevent the presence of a population of wood ducks in the Rest of River.***

In Section 2.4.8, numerical RMCs were presented for PCBs in aquatic invertebrates based on consumption by wood ducks in the Rest of River, using methods and assumptions consistent with the ERA. However, for reasons given in prior GE comments (BBL et al., 2005), we believe that the ERA employed a number of overly conservative assumptions and that more accurate and realistic RMCs can be generated using alternative methods. Such alternative numerical RMCs are presented in this subsection. Such RMCs have been developed for both total PCBs and TEQs, because the ERA concluded that, while the predicted risks from both PCBs and TEQs are similar in magnitude, the certainty of the predicted TEQ risks to wood ducks is slightly higher than that for PCBs (ERA, Vol. 2, pp. 7-67, 7-68; Vol. 5, p. G-130, Tables G.4-22, G.4-23).

To generate alternative RMCs, the HQ equation was solved for the prey concentration term, while holding the HQ value at a target level of 1.0. While the ERA generated HQs for PCBs as the ratio of modeled doses to dose-based TRVs, its HQs for TEQs were egg-based – i.e., expressed as the ratio of modeled concentrations of TEQs in wood duck eggs to egg-based TRVs (ERA, Vol. 2, pp. 7-11, 7-53 – 7-57; Vol. 5, pp. G-86, G-89 – G-91). However, for the alternative RMCs, dose-based TRVs were used to generate RMCs for both PCBs and TEQs due to concerns with the certainty of the egg-based approach and effects metric. In particular, as detailed in Attachment 29 (in Appendix E), the use of the Bargar et al. (2001) study to estimate maternal transfer biases the TEQ RMCs low. Using white leghorn chickens, Bargar et al. (2001) quantified maternal transfer of PCBs to eggs based on ratios of concentrations in eggs and hens. Due to the considerable differences in the relative masses of hens and eggs between white leghorn chickens and wood ducks, Bargar et al.'s (2001) concentration ratio overestimates maternal transfer in wood ducks. In addition, use of the egg-based TEQ TRVs derived from the field study of wood ducks (White and Seginak, 1994) used in the ERA would introduce a number of confounding factors into the analysis. For example, White and Seginak (1994) employed the International TEQ system (EPA, 1989b), whereas the ERA employed the World Health Organization's TEQ system (Van den Berg et al., 1998) (ERA, Vol. 2, p. 7-41; Vol. 5, p. G-84). In addition, the mixtures of dioxins, furans, and PCBs differ substantially between the Rest of River and the site where that study was conducted, Bayou Meto, Arkansas. Dioxins are the main constituents in Bayou Meto, while PCBs are predominant in the Rest of River. The different mixtures may have different toxicities that are not fully reflected in TEQs. These differences, as well as other potential inter-site differences (e.g., in food sources, bioenergetics, co-contaminants, breeding season duration, etc.), would contribute further uncertainty to egg-based TEQ RMCs. For these reasons, dose-based TRVs were used to generate RMCs.

The following equations and assumptions were employed in deriving the alternative dose-based RMCs:

$$RMC_{prey} = THQ * TRV / (FT * P_i * FIR)$$

Where:

RMC_{prey}	=	Concentration of PCBs in wood duck prey that will not result in exceedance of dose-based TRV (mg/kg)
THQ	=	Target hazard quotient (unitless)
TRV	=	Toxicity reference value (mg/kg bw/d)
FT	=	Foraging time (unitless)
P_i	=	Proportion of invertebrates in diet (unitless)
FIR	=	Normalized food intake rate (kg/kg bw/d)

As previously noted, the THQ was set at 1.0 to ensure that the dose does not exceed the TRV. For PCBs, the same three dose-based TRVs discussed in connection with ospreys in Section 3.4.6 were used – i.e., (a) 1.4 mg/kg bw/d, reflecting the NOAEL for the mallard (Custer and Heinz, 1980), to represent the most sensitive wild avian species; (b) 15.7 mg/kg bw/d, derived from Custer's (2002) study on tree swallows breeding on the Housatonic River, to represent the most tolerant species; and (c) 8.55 mg/kg bw/d, the midpoint of the other two TRVs.

Similarly, three dose-based TRVs for TEQs were employed. The first, 44 ng/kg bw/d, reflects the geometric mean of the NOAEL and LOAEL for the most sensitive wild avian receptor, the ring-necked pheasant (Nosek et al., 1992). The second, 25,000 ng/kg bw/d, is the threshold at which Hoffman et al. (1996) observed statistically significant effects in American kestrels (although the effects observed did not translate into significant effects on hatchling success or growth). The third, 13,000 ng/kg bw/d, is the midpoint of the other two TRVs. [The TRVs of 44 ng/kg bw/d and 25,000 ng/kg bw/d were also employed in the ERA to evaluate TEQ risks to avian species other than wood ducks (ERA, Vol. 1, pp. 7-40, 8-20; Vol. 5, p. G-83; Vol. 6, p. H-48).]

RMCs were calculated based on an assumed foraging time (FT) of 1.0. The proportion of invertebrates in the diet (P_i) was assumed to be 0.645, based on the average of the diets during the pre-laying and egg-laying periods (Drobney and Fredrickson, 1979; Drobney, 1980).

The normalized food intake rate (FIR) was calculated as:

$$FIR = (FMR * CF) / \sum_{i=1}^{n} (AE_i * G_i * P_i * BW)$$

Where:

FIR	=	Normalized food intake rate (g/g bw/d)
FMR	=	Free metabolic rate (kJ/d)
CF	=	Conversion factor (0.239 kcal/kJ)
i	=	Prey item type (unitless)
AE	=	Assimilation efficiency (unitless)
G	=	Gross energy (kcal/g)
P_i	=	Proportion of prey item i in diet (unitless)
BW	=	Body weight (g)

Inputs for calculating the FIR were all consistent with values employed in the ERA (Vol. 5, pp. G-45, G-46, Table G.2-33). The assimilation efficiencies (AEs) of terrestrial invertebrates and aquatic invertebrates by birds were assumed to be 0.72 and 0.77, respectively, based on

Karasov (1990), Ricklefs (1974), and Bryant and Bryant (1988). Terrestrial and aquatic invertebrates were assumed to have gross energies (G) of 1,600 kcal/kg and 1,100 kcal/kg, respectively, based on Cummins and Wuycheck (1971), Collopy (1975), Bell (1990), Tyler (1973), Jorgensen et al. (1991), Minnich (1982), and Thayer et al. (1973). The proportion of diet comprised of terrestrial invertebrates was assumed to be 0.166, while the proportion of diet comprised of aquatic invertebrates was assumed to be 0.479, based on Drobney and Fredrickson (1979).

The free metabolic rate (FMR) was calculated as:

$$FMR = a * BW^{b}$$

Where:

FMR	=	Free metabolic rate (kJ/d)
a	=	Slope (kJ/g-d)
BW	=	Body weight (g)
b	=	Power (unitless)

Average values reported in the ERA (Vol. 5, pp. G-45, G-46, Table G.2-33) for all three terms were applied, including a slope of 10.5, body weight of 564 g, and power of 0.68.

Using these procedures, the range of alternative RMCs for PCBs in wood duck prey is 6.1 mg/kg to 68 mg/kg, with a midpoint of 37 mg/kg. The range of alternative RMCs for TEQs in wood duck prey is 1.9×10^{-4} mg/kg to 1.1×10^{-1} mg/kg, with a midpoint of 5.5×10^{-2} mg/kg. These TEQ RMCs are equal to a range of 190 ng/kg to 109,000 ng/kg, with a midpoint of 54,500 ng/kg.

Attachment B

Methodology for Determining IMPG Attainment for Insectivorous Birds and Piscivorous Mammals for SED/FP Combinations under the Alternate Ecological Evaluation

Attachment B

Methodology for Determining IMPG Attainment for Insectivorous Birds and Piscivorous Mammals for SED/FP Combinations under the Alternate Ecological Evaluation

B.1 Introduction

As described in Section 2.3 of the foregoing *Evaluation of Remedial Alternatives Using Sound Ecological Assumptions* (referred to herein as the Alternate Ecological Evaluation) and in Section 4.2.3.5 of the Revised CMS Report, the procedure for evaluating Interim Media Protection Goals (IMPGs) for two groups of animals – insectivorous birds (represented by wood duck) and piscivorous mammals (represented by mink) – is complicated by the fact that these animals consume a mix of aquatic and terrestrial prey sources, which causes their IMPGs to be expressed in terms of prey concentrations that are tied to both sediment and floodplain soil PCB concentrations. In the Revised CMS Report, the procedure for evaluating IMPG attainment for these receptors (as described in Section 4.2.3.5 of that report) for a given combination of sediment and floodplain alternatives involved the following steps: (1) determination of the sediment PCB concentration predicted by the EPA model at the end of the projection period for the sediment component of the combination in the relevant averaging area(s); (2) for each such area and sediment concentration, calculation of an associated target floodplain soil level that would allow attainment of the relevant IMPG using the methods described in Appendices D (wood duck) and E (mink) to the Revised CMS Report; and (3) comparison of the post-remediation floodplain soil concentration achieved by the combination in that averaging area to the target floodplain soil concentration calculated for that area.

For purposes of assessing IMPG attainment for these groups of animals in the Alternate Ecological Evaluation, these same procedures were used, except that certain modifications were made to reflect the alternate IMPG values and averaging areas discussed in the text of the Alternate Ecological Evaluation. These modifications are described in this Attachment, along with the results, which include the model-predicted sediment levels and the calculated associated target floodplain soil levels for insectivorous birds and piscivorous mammals under each of the alternative combinations evaluated in the Alternate Ecological Evaluation (i.e., SED 2/FP 1, SED 3/FP 3, and SED 10/FP 9).

B.2 Calculation of Floodplain Target Levels for Insectivorous Birds

B.2.1 Methodology

For purposes of the Alternate Ecological Evaluation, the procedure used in the Revised CMS Report for evaluating attainment of the insectivorous bird IMPGs (described in Appendix D to the latter report) was modified as follows:

- As discussed in Section 2.3 of the Alternate Ecological Evaluation, the IMPGs used for PCB concentrations in prey items consisted of a lower-bound value of 6.1 mg/kg, a midpoint value of 37 mg/kg, and an upper-bound value of 68 mg/kg.

- As discussed in Section 2.4 of the Alternate Ecological Evaluation, the calculations were performed for the entire PSA as a single averaging area (rather than the various smaller areas evaluated in the Revised CMS Report). Use of the entire PSA as a single averaging area affected the calculation of target floodplain soil levels in two ways. First, model-predicted sediment concentrations were calculated as a spatial average over the entire PSA. Second, certain input values used in the equations to calculate target floodplain soil levels (e.g., see Equation 7 in Appendix D of the Revised CMS Report) were specified as PSA-wide averages rather than the reach-specific values used in the Revised CMS Report (see also Table D-1 of the Revised CMS Report). These inputs included the total organic carbon (TOC) content of the sediments and biota-sediment accumulation factors (BSAFs). The PSA-wide averages for these parameters were calculated using the same data and procedures used to develop the reach-specific values, as described in Appendix D of the Revised CMS Report. The resulting area-weighted average sediment TOC content for the PSA is 6.9%. For the BSAFs, EPA's model was used to generate BSAFs applicable to the entire PSA.[1] The resulting PSA-wide average BSAFs were 0.452 for water column invertebrates and 1.047 for epibenthic invertebrates.

All other input values, equations, and assumptions were the same as those described in Appendix D to the Revised CMS Report.

B.2.2 Results

The model-predicted sediment levels and the associated target floodplain soil levels for insectivorous birds calculated based on the above procedure are provided below in Table B-1 for each of the combinations of sediment and floodplain alternatives evaluated herein (SED 2/FP 1, SED 3/FP 3, and SED 10/FP 9).

Table B-1. Target Floodplain Soil Levels for Alternate Insectivorous Bird IMPG Assessment

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[1] Average PSA-wide invertebrate BSAFs were computed by dividing area-weighted average tissue concentrations predicted by EPA's model by the area-weighted average sediment concentrations (also from EPA's model) on a daily time step. The overall average BSAFs were computed over the 26-year simulation based on April - July values (i.e., the same method as described in Appendix D of the Revised CMS Report).

Model-Predicted Sediment Endpoint PCB Concentrations (mg/kg) [1]			IMPG (PCB Concentration in Prey Items)	Calculated Target Floodplain Soil Levels (mg/kg)		
SED 2/ FP 1	SED 3/ FP 3	SED 10/ FP 9		SED 2/ FP 1	SED 3/ FP 3	SED 10/ FP 9
15	5.1	11	Lower Bound: 6.1 mg/kg	49	67	57
			Midpoint: 37 mg/kg	436	454	443
			Upper Bound: 68 mg/kg	824	841	831

[1] Model-predicted 0-6" sediment concentration, area-weighted average over the PSA.

To evaluate achievement of the alternate insectivorous bird IMPGs, the target floodplain soil levels shown in Table B-1 for each of these combinations were compared against the average floodplain levels achieved by that combination in the overall PSA, as discussed in Section 3.1.2 of the Alternate Ecological Evaluation.

B.3 Calculation of Floodplain Target Levels for Piscivorous Mammals

B.3.1 Methodology

The procedure used in the Revised CMS Report for evaluating attainment of the piscivorous mammal IMPGs (described in Appendix E to that report) was likewise modified in certain respects. First, as discussed in Section 2.3 of the Alternate Ecological Evaluation, the IMPG assessment was based on an IMPG of 3.7 mg/kg PCBs in mink prey items. Second, the averaging area used for assessing IMPGs consisted of the entire PSA, as discussed in Section 2.4 of the Alternate Ecological Evaluation. As a result, model-predicted sediment concentrations were calculated as a spatial average over the entire PSA, and several of the reach-specific input parameters used in the calculation of floodplain soil target levels (see Equation 16 and Table E-1 in Appendix E of the Revised CMS Report) were modified to represent average values over the entire PSA. These parameters were bioaccumulation factors (BAFs) and BSAFs for prey items, lipid contents of prey items, and the organic carbon fraction in sediment. The PSA-wide averages for these parameters were calculated using the same data sets, procedures, and assumptions used to develop the reach-specific values (see Table E-1 in Appendix E to the Revised CMS Report). The resulting PSA-wide values are shown below in Table B-2.

Table B-2. PSA-Wide Average Input Parameters used in Alternate Calculation of Target Floodplain Soil Levels for Piscivorous Mammal IMPG Assessment.

Parameter	Description	Values used in Revised CMS Report		PSA-wide Average Value used in Alternate Ecological Evaluation
		Reaches 5A/5B	Reaches 5C/5D/6	
$BSAF_i$	Invertebrate BSAF	0.56	1.23	0.79
$BSAF_f$	Fish BSAF	1.32	1.33	1.33
$BSAF_a$	Amphibian and reptile BSAF	0.55	2.36	1.32

$BSAF_{ab}$	Aquatic bird BSAF	1.72	0.318	0.574
BAF_{tb}	Terrestrial bird BAF	2.43	1.13	2.13
BAF_{tm}	Terrestrial mammal BAF	0.339	0.918	0.440
BAF_{ab}	Aquatic bird BAF	0.348	0.208	0.300
$LIPID_i$	Invertebrate lipid fraction	0.011	0.009	0.010
$LIPID_f$	Fish lipid fraction	0.030	0.030	0.030
$LIPID_a$	Amphibian and reptile lipid fraction	0.017	0.011	0.013
$LIPID_{ab}$	Aquatic bird lipid fraction	0.017	0.062	0.044
FOC_{sed}	Sediment organic carbon fraction	0.025	0.089	0.069

In addition to using these PSA-wide averages, the calculation of target floodplain soil levels took into account the portion of the mink's foraging range that is outside of the defined floodplain in the PSA – i.e., the 1 mg/kg PCB isopleth. To do so, GE used a "foraging area" that better represents the foraging range of mink that use the PSA. As discussed in Section 2.3 of the Alternate Ecological Evaluation, mink have home ranges in riverine habitats that extend laterally about 200 meters from the shoreline and also include tributaries as well as the main stem of the River. Thus, the foraging area used herein, shown on Figure B-1, includes a corridor that extends 200 meters from the shoreline on both sides of the River in the PSA (which goes beyond the 1 mg/kg PCB isopleth in many areas) and also includes such corridors along a number of tributaries to the River, extending a distance of 0.75 km up each tributary from its mouth – excluding from these corridors areas delineated as unsuitable mink habitat. This area covers approximately 2,100 acres, of which the portion within the 1 mg/kg isopleth covers 726 acres, or 35% of the total area. As such, the equation used to calculate the target floodplain soil levels that would result in achievement of the alternate piscivorous mammal IMPG (i.e., Equation 16 in Appendix E of the Revised CMS Report) was divided by a factor of 0.35 for the Alternate Ecological Evaluation to account for the proportion of mink diet that would come from areas outside the 1 mg/kg PCB isopleth (and therefore assumed to have no detectable PCBs).

All other inputs and assumptions used in the calculation of target floodplain soil levels for piscivorous mammals were the same as those described in Appendix E of the Revised CMS Report.

B.3.2 Results

Using the modifications described above with the approach described in Appendix E of the Revised CMS Report, target floodplain soil PCB concentrations associated with achieving the alternate mink IMPG value of 3.7 mg/kg were computed for each of the combinations of sediment and floodplain alternatives evaluated herein (SED 2/FP 1, SED 3/FP 3, and SED 10/FP 9). The model-predicted sediment levels within the PSA averaging area and the associated target floodplain soil levels calculated based on the above procedure are provided below in Table B-3 for these combinations.

Table B-3. Calculated Target Floodplain Soil Levels for Alternate Piscivorous Mammal IMPG Assessment.

Model-Predicted Sediment Endpoint PCB Concentrations (mg/kg) [1]			IMPG (PCB Concentration in Prey Items)	Calculated Target Floodplain Soil Levels (mg/kg)		
SED 2/ FP 1	SED 3/ FP 3	SED 10/ FP 9		SED 2/ FP 1	SED 3/ FP 3	SED 10/ FP 9
15	5.1	11	3.7 mg/kg	n/a [2]	66	27

[1] *Model-predicted 0-6" sediment concentration, area-weighted average over the PSA.*

[2] *n/a indicates that attainment of the IMPG is not possible because, at the given sediment concentration, PCB levels in aquatic prey alone would exceed the IMPG, regardless of the floodplain concentration.*

To evaluate achievement of the alternate piscivorous mammal IMPG, as discussed in Section 3.1.2 of the Alternate Ecological Evaluation, the target floodplain soil level shown in Table B-3 for SED 3/FP 3 and SED 10/FP 9 was compared against the average floodplain level achieved in the PSA by each of those combinations. As shown in Table B-3, under SED 2/FP 1, no floodplain level would achieve the IMPG for piscivorous mammals, since that IMPG would be exceeded based on the predicted sediment concentration alone.

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Project #: B00309290002 00001
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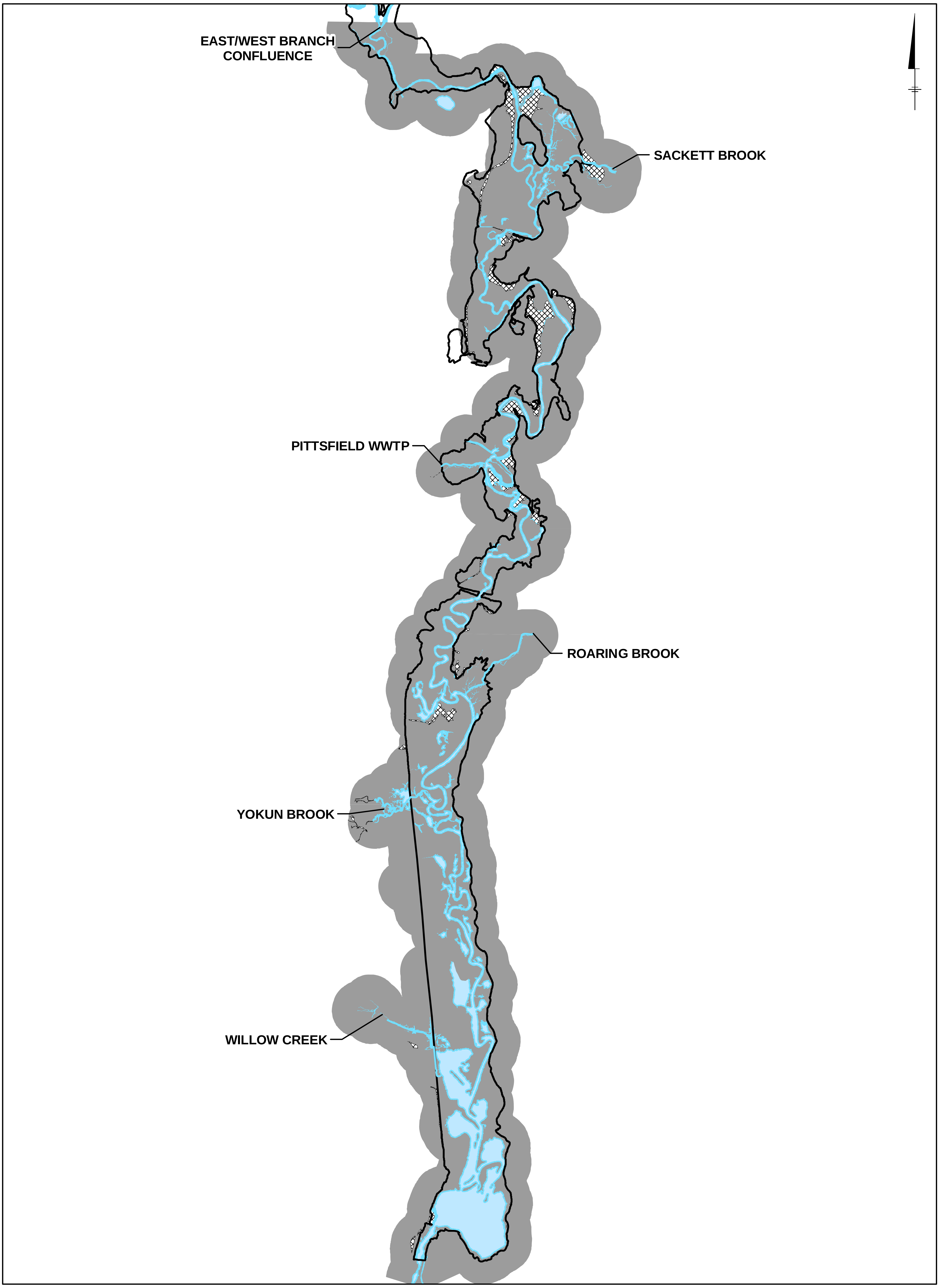

LEGEND

- PCB 1 MG/KG ISOPLETH
- MINK HABITAT
- WATERBODIES
- UNSUITABLE MINK HABITAT

NOTES:

1. MINK HABITAT (GRAY) IS DEFINED AS SUITABLE HABITAT WITHIN A 200-M DISTANCE OF ALL WATERBODIES INCLUDING THE RIVER MAINSTEM, BACKWATERS, PONDS, AND TRIBUTARIES (EXTENDING APPROXIMATELY 0.75 KM FROM THE MAINSTEM).
2. TRIBUTARIES ARE LABELED

0 2,000 4,000 Feet

GRAPHIC SCALE

HOUSATONIC RIVER - REST OF RIVER

LOCATION OF MINK HABITAT AND 1 MG/KG PCB ISOPLETH

ARCADIS

FIGURE B-1